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THE COVER: Artist Furno's concept of the proposed new United Engineering Center to be located on United Nations Plaza between 47th and 48th Streets, New York, N.Y. Architects are Shreve, Lamb & Harmon Associates. Story on page 1090.

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Impact of New Engineering Concepts on Engineering Education

J. F. CALVERT
FELLOW AIEE

Areas in which the concepts of information, control, and computing theory can exert their greatest impact—memory and recall, routine calculation, and decision making—are explored. Research is urged for their application to the fields of discovery and engineering creativity.

OVER THE PAST DECADE or two a large number of articles have appeared which were concerned with one or more of the new concepts of information, control, and computing theory. Most have been concerned with new and often very technical developments. Some have pointed out the interactions to occur between these concepts when applied to present and future engineering problems. Others have suggested applications to biology. A few authors have touched on potential applications in the social sciences. It is my purpose to discuss these new concepts as a group and specifically in relation to engineering education.

New ideas and new concepts, such as these to be discussed, flourish best where best cultivated and we are fortunate that engineers have evolved many of the new ideas and have contributed so much to their growth. Some of the best informed among the engineers have suggested that these new concepts carry the seeds of a second industrial revolution. The conquest of physical power ultimately relieved millions of much physical drudgery and, it is argued, these new ideas will alleviate the boredom for thousands whose work is bound down by repetitive mental routines. If this be the case, changes must come not only through discovery, invention, and manufacture, but also through formal and informal education.

However, beyond these mental routines, engineers see ways to solve larger problems with greater accuracy than was dreamed of 20 years ago. In the past, we have been much concerned with what these new concepts mean to engineering. My purpose is to discuss how these new concepts of information, control, and computing theory may influence engineering education. A rather natural start—but only a start—might be made through a tabulation such as that shown in Table I. Here we see the substitution of new ways of problem solving for old, with the suggestion of greatly increased speeds and powers of attack. Yet, few new methods of attack are suggested. Taken collectively, these substitutions look more like an extensive "retooling operation" than they do like an intellectual revolution.

We really need to review those ways of thinking common to all engineering and, in fact, common to intellectual effort far afield from engineering. If these be seriously affected by our new concepts, then, indeed a revolution may be in the offing.

A special article recommended for publication by the AIEE Educational Publications Committee. This article is based on a discussion presented at a seminar on the occasion of the inauguration of Chancellor E. H. Litchfield as the 12th chancellor of the University of Pittsburgh.

J. F. Calvert is head of the Department of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

RELATION OF CONCEPTS TO KINDS OF THINKING

WE SHOULD TALK about the following: (1) memory and recall of information; (2) routine mental operations; (3) single-level and multiple-level judgments; (4) discovery; and (5) invention. All of these play their part in engineering; each should be a part of engineering education.

To see how the new concepts may affect teaching in these various areas, we need to start from somewhere; we need a datum line, or bench mark, against which we may measure prospective change. To provide such a reference, let us select the ways of teaching and the kinds of thinking used now and in the recent past at the majority of engineering schools in the United States. Most of us are very familiar with these references, so that with these established we may return to the consideration of the kinds of thinking mentioned previously.

Memory and Recall of Information. Today, we place in libraries immense stores of printed information. True, we change the size of the print down and up with microfilm and projector, but essentially we write, we store, and we recall again what we write. More often than not, it remains unchanged in the fine detail in which it was prepared by the original author.

The ways in which information may be stored through the use of microfilm, magnetic tape, and magnetic cores, and how it may be transmitted and recalled via teletype, radio and television, and photography are all too well-known to be detailed here. One example will suffice to show the magnitude of the already achieved mechanical advances. It was reported, a few years ago, that the unusually long novel "Gone with the Wind," which contained 1,037 pages and about one million words, was transmitted and recalled with the aid of television and photography in less than 90 seconds. Just this should make some things clear.

Thus, although we speed up these operations by many magnitudes, we produce no such speed-up in our mental operations. Now, we read "Gone with the Wind" for pleasure (if not edification) and so here speed is really of no consequence. But the same speed of memory

Table I. Computational Procedures—Old and New

Some of the things with which colleges have and have not dealt	Some additional things which may be dealt with through the new concepts and new equipment associated with information, control, and computational theory
Engineering Education has dealt with:	
1. Recording, using charts, tables, texts, journals, and the usual "look-up" procedures of a library.	1. Memory devices such as microfilm, magnetic tape, and magnetic cores—combined with the high-speed transmission of information—will completely change our outlook on information storage and recall.
2. Linear systems of equations for static problems involving several (mathematical) variables, but not too many variables because of the time required to get answers.	2. Simultaneous linear equations for static problems (50 to 100 equations) can be solved with great accuracy, reasonable dispatch, and no wear and tear on the human mind.
3. Differential equations—total or partial—but not too complicated. They are almost always linear and relate to three dimensional space and to time.	3. Dynamic situations, expressed in the form of ordinary and partial differential equations, may be solved which heretofore would have been regarded as hopeless from the start.
4. Much of engineering education has not dealt extensively with statistics and probability.	4. Stochastic variables can be treated, and a variety of correlations made for the extraction of information from a signal including information and noise.
5. Methods of solution have been geared to the use of the slide rules, adding machines, desk calculators, charts and models.	5. Methods of solution, at least for large problems (also for many smaller ones where repetitive work is involved), may be geared to automatic computational procedures.

and recall could be used to store and bring forth again an abstruse technical report and if, in our engineering work, we try to assimilate the details that are recalled, our minds soon slow down the entire operation. Obviously, this is not what we should be doing. Instead we should find more generalizations—many of them new generalizations which are directly associated with our new devices—so that when answers come out, they reach us in forms which are condensed, generalized, more easily assimilated, and easier to use. Then we can act upon them with some dispatch.

The search for such generalizations and condensations of knowledge soon after discovery—ways of fitting new ideas into the common body of knowledge—have always been a part of the educational processes. However, the ways themselves must be given intensive study as never before. Unless we do this, the alternative is to make of quite large numbers of educated men mere cogs in huge idea factories. The really new and outstanding ideas always will be developed by a relatively few people. It is hoped, however, that many men may have the opportunity to contribute to the limit of their potential abilities. We speak with some awe of the thousands or even millions of man-hours invested in the designs of new aircraft. We act as though the replacement of routine calculations by machine calculations will change all of this. It will be a big step, as will be discussed later, but it has little to do with the way we bottleneck the business of storage, recall, and assimilation of knowledge. The speed now available in memory and recall will necessitate much research on packaging for later assimilation. This begs for a revolution in educational methods.

Routine Mental Operations. This is a loosely used phrase. Some people reserve it for work done in fields other than their own. I shall try to tighten down a little on its meaning. Suppose reference is made to those operations (1) which can be set up in formula so that given certain "causes" we get just one "result," and (2) in which no corrective action such as feedback or other weighing and comparing action is introduced. Thus, strictly arithmetical operations and the substitution in a formula or a series of formulas, no matter how involved, would fall within this classification. By and large, bookkeeping operations, or just filling out calculation sheets could be regarded as routine operations provided few real judgments were required of the minds of human operators.

The use of computing machines in any of these areas has three possible merits.

(1) A computer may solve a problem much more quickly and accurately, and also much more cheaply, than can be done by any other procedure. It is reported that with only a medium sized computer the American Bridge Company saved 10,000 man-hours of computing time in relation to the Makinac Bridge.

(2) A computing machine may solve a problem which, because of the inherent complexity, would be impracticable to solve by any other known process. Thus, without the machine, the cost might be too high, or the solution might be so slow in coming through via human operations alone that the situation for which answers were needed would no longer exist.

(3) Some of the known methods for solving problems—even in pure mathematics—have been influenced or restricted in the past by the "tools" available and may become less restricted as new tools are devised. Thus, if one wants the solution to an ordinary linear differential equation subject to certain boundary conditions, he finds by the classical procedure the particular integral and the complimentary function and then he introduces the boundary conditions. Not so with an analogue computer (which is a sort of model for the specific case). Here one may put in the whole situation including the boundary conditions and the recording of answers may be entirely automatic.

Problems Involving Judgment. This phrase may call for some explanation. Suppose, for instance, that a man is making a conscious effort to carry out certain operations in a continually varying situation. Perhaps he is simply driving a car at night on the open road. He is inclined to feel that some judgment is called for (partly by himself and always by the other driver). And so we will treat these types of operation as ones calling for judgment. We know that when human action is replaced by machine action, the situation must be so specified that the machine can "sense" the situation and always act in a fashion which is as "intelligent" as it is capable of acting. It may be only egotism at work but, at this point, people wonder whether the action really should be called "judgment." However, in terms of the references which are the methods of the recent past, we could label this as judgment inasmuch as human judgment has been replaced and released for other potential uses.

The following are problems widely dealt with today

and it seems justifiable to classify them at least as ones where, when treated in a fully automatic fashion, a certain degree of human judgment has been so released for the other potential uses:

1. Problems of control, where the operation being controlled is either a continuous or a batch process.
2. Elaboration of preceding item 1 for certain phases of automation.
3. Optimization of linear functions where the functions are subject to linear restrictions (a procedure sometimes known as linear programming).

There are other problems being solved or elaborated and also ones which we may expect to see solved in the foreseeable future. Among these are the following:

1. The separation of sense from nonsense in elaborate forms of intelligence, such as, speech and also in that intelligence which is used in involved automatic processes.
2. The reduction of redundance in transmitted information.
3. New methods for overriding nonlinearities and other deviations from the linear in system performance in order to extend, with a reasonable degree of certainty, the use of superposition techniques.
4. Optimization of nonlinear functions of many variables where the function may be expressed in analytic form and also where it appears only in succession of graphs, charts, or other tabular forms. The restrictions may be linear or nonlinear and the necessity for selection between many optimum conditions may be expected.
5. Multiple level optimization problems will arise. Here parts of the system may be optimized: this means that several separate functions are optimized, not all of which are functions of all the variables; or it may mean that several separate functions are to be optimized, each of which is a function of all the variables; or both the requirements could appear. Then at higher levels it may be found that all sublevel requirements cannot be met by any solution or else that within some bounds they can be met. Thus, further decision-making is required.

The decisions may yield unique answers or they may yield answers which have bounds; i.e., the answers may be greater than or less than certain limits. The answers may appear as compatible sets of values, any one part appearing either in discrete or bounded form.

Problems Related to Discovery. In their broader interpretations discovery and invention are as two sides of the same coin in the intellectual realm. Both really involve many sorts of thought processes and, in fact, many of the same processes are used in each. What may seem to be discovery may turn out to be part of invention, and the reverse may be true also. Nevertheless, some attempt will be made here to separate these operations of discovery and invention. This idealization or simplification will be introduced in order that these two large operations may be discussed with a somewhat greater degree of clarity.

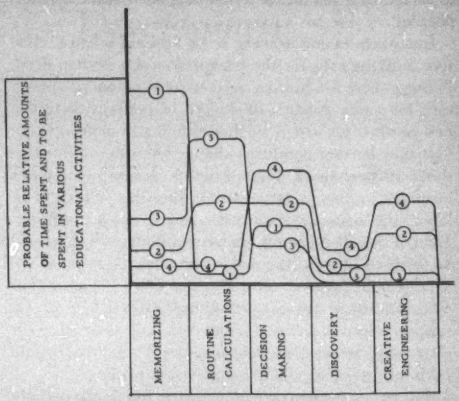

Fig. 1. Various Educational Activities. *(1) In ancient times; (2) Today in engineering education; (3) Direct supplementary influences of the new concepts; (4) Future in engineering education.*

Ordinarily, I tend to associate discovery more with those as yet unapplied areas of the natural sciences, and I associate invention with engineering. Yet it seems likely that certain aspects of information theory may be closely associated with discovery. The separation of the relevant from the irrelevant and the reinforcement of meaning obtained through redundacy would imply these possibilities.

Problems Related to Invention. In the legal sense, invention has to do with what is patentable and in its legal sense it is sharply distinguished from discovery in the natural sciences. Laws of nature cannot be patented. For simplicity, the term invention will be used in a broad sense, although still excluding the discovery of laws of nature. Invention will be used synonymously with those creative endeavors which are clearly definable in engineering.

Those of us in engineering teaching hope that large numbers of our graduates will go forth to creative endeavors in design, in research, and in management. Large numbers do go eventually into all of these areas of engineering and the great majority of them are successful in their work. At the same time, those of us in education worry because we realize that the arts of developing those elusive qualities needed for creative work are not well defined, and measurements are all but impracticable.

At present, there is no way for our new-found concepts of information, control, and computational theory to take over much, if any, of the creative work of the engineer. These new concepts will offer new tools to speed the work of trial and error, and successive approximations made in the quest for good results. They will, thereby, call for much more creative activity on the part of engineers. Therefore, we need to face up to the need for concentrated studies on ways to develop a man's natural capacities for creative work. Next, I hope

to sketch in a few ideas concerning such work in engineering.

Inasmuch as engineering is an applied science, creative thinking calls for the recognition of a human need. Perhaps there is a human need—real or potential—which calls for a new product or design; or perhaps there is a new product for which we should find a human want.

It may be that engineers should be better trained in the classification of human needs under such major headings as the preservation of life, the reduction of labor, the removal of inconveniences, or the improvement of travel and communications. Perhaps they should be asked to imagine the needs or desires of people if the average real income were to increase by 10%, 30% or 60% (and these are not actually unrealistic figures). Or suppose electric power should cost half as much as it does today in terms of real income. Then what would both industrialists and urbanites want of it?

Instead of having problems stated for them, perhaps young engineers should have much more experience in clearly stating problems of their own. One form for this is shown as follows:*

(1)—The object is to design (or) to produce (or) to organize (or) to adjust	Here the student would state what it is.
(2)—In order to overcome the following obstacles:	And here he must set forth the obstacles as completely as possible and attempt to indicate relative importance.
(3)—In such a way that the following specified aims will be achieved	And here, too he must set forth items showing, perhaps, necessary minimum requirements below which he should not go and maximum values beyond which no appreciable advantage is to be gained. A grading procedure is desirable for comparing alternative solutions (when they are discovered) which fall within these bounds.

Although automatic programming in computing machines begins to look like the rudiments of problem solving, still it seems that we are not quite ready to try to substitute the techniques of information, control, or computing theory for human activity in creative engineering work. This does not imply that these concepts fail to have application as checks and as devices for providing information. They do so serve today.

The truly new products and organizational procedures seem not often found through exacting analyses, but arise from new views, new discoveries, or bold syntheses. They are caught first in qualitative terms and painted in sweeping strokes with a broad brush. "Intuition," Sikorski says, "is the forerunner of knowledge" which whispers of the correctness of things that only later may be produced. New ideas and new designs, stem from images—a series of forms, colors, or sounds, appearing within the mind—and intuition is that sense of rightness which appeals for a conscious check. The search for a solution often is a quick probing—a running through of a few sequential ideas—the use of analogies to clothe the unfamiliar in more familiar garb. Creative work in engineering calls not only for a knowledge of science and industry but for the spirit of art, yet there are a few definable abilities and work methods. These, however, seem as yet unsuited to the applications of the new techniques of information, control, and computing theory except as the latter may be employed in checking or in data collecting including comparisons and optimizations.

* A form suggested by the late Dr. R. H. Seashore, formerly Chairman of the Department of Psychology, Northwestern University.

CONCLUSIONS

TWO FINAL TASKS REMAIN. The first is to sum up the possible implications of these new concepts for engineering education. The second is to suggest how all of this may take its place in the continuing stream of human thought which so strongly flows in a free society.

First, again some of the suggested implications for engineering education. In those areas of thinking where the new concepts can make the greatest direct contributions—that is, to memory and recall, to routine calculation, and to decision making—teaching should be changed to show how an engineer may avail himself of these new powers. In these same areas, research should go on in order that the speed of data handling and computing may yield generalized and intellectually more useable results.

Research should go on, too, in an effort to extend the direct use of the new concepts to the broad fields of discovery and of engineering creativity. But this means learning more about the basic natures of these two activities. One timely way to start is to try, more scientifically, to help student minds develop along these lines. In the long run, experimentation and research done here probably will pay off tenfold more than similar efforts applied to purely mechanized treatments of memory and recall, calculation and decision making. Fig. 1 shows a chart to express certain of these developments.

Finally, we should view our own position in education for a free society. At the colleges and through our professional societies, which in themselves are educational bodies, we seek to advance the art and we endeavor to bring on a revolution in the work of the engineering mind. There are, however, continuing principles for such a society—some of these intuitively fitting for the future. Thomas Jefferson, himself statesman, author, and engineer, said of the university which he founded: "This institution will be based upon the illimitable freedom of the human mind. For here we are not afraid to follow the truth wherever it may lead, nor tolerate error so long as reason is left to combat it." And we, too, may continue in that view, for although new concepts open new vistas, it remains true that, for the mind, higher education is both learning and discovering how to learn: for the heart, not alone the incentive to go on discovering, but a sense of wonder, and yet a will to act while life does last.

The Bersimis-Lac Cassé Development

H. F. ABBOTT
MEMBER AIEE

ALTHOUGH LOCATED 400 MILES from the Montreal industrial center and set 65 miles into wilderness, the site for the Bersimis–Lac Cassé development was chosen because it was economic and would open the eastern reaches of the St. Lawrence River to industrial growth.

In general, the project includes developing storage at the foot of Lac Cassé or head of the Bersimis River by building two large dams to raise Lac Cassé (natural elevation 1,145 feet) and the larger Lac Pipmaucan (natural elevation 1,225 feet) to an elevation of 1,300 feet. This taps a drainage area of 5,010 square miles and gives a storage basin of 290 square miles containing 410 billion cubic feet with a usable storage of 168 billion cubic feet for 25 feet of drawdown. Although the site is in an uninhabited region and is rough and mountainous, it has some value in virtue of its timber, so that the elevation of the head pond is limited partly by cost of additional timbered areas and partly by the cost of dam extensions and further dams.

By reason of the drainage area, an average flow of 9,320 cubic feet per second is envisaged, and by leading this through a tunnel 7½ miles long and 31 feet in diameter it is economically feasible to bypass about 18 miles of river bed to get to a point on the river at elevation 425 feet where the powerhouse is built, realizing a gross head of 875 feet.

It had been decided to design Bersimis for 70% load factor plus a spare unit, or 1,070,000 hp plus a spare unit, at minimum head. The result was eight units with a nominal rating of 150,000 hp at minimum head of 785 feet; actually the output is about 171,000 hp per unit at the more normal 830-foot head. While the size of units arose from economic reasons, the large capacity is almost essential to satisfactory operation of long lines, and led to a short-time capability for line charging of 238 mva per unit in generators dual rated 120 to 138 mva.

To transmit power to Montreal, recent progress in high-voltage transmission gave some assurance that technical and equipment difficulties could be overcome, to the extent that voltages as high as 400 kv could be considered. On economic grounds, 300-kv double-circuit lines were selected. Special care was given to obtaining blemish-free conductors, special corona shielding, streamlined fittings, generous insulation, and proper conductor sizes and clearances in order to assure satisfactory operation.

Because it is necessary, in the case of long lines, to work close to the stability limit for economic reasons, special consideration was given to intermediate switching stations, methods of decreasing interruptions, protective relaying, automatic reclosing, communication, and control. An intermediate switching station is provided near Quebec, 250 miles from Bersimis, where a large load is tapped off. With fast relays and automatic reclosing within 20 seconds, applying to the two double circuits from Bersimis to Quebec and the one double circuit from Quebec to Montreal, the operating limit at the Bersimis end is calculated to be about 900 mw at 315 kv. Mechanical and electrical details of the lines and switching stations are designed with ample operating margin to reduce interruptions to a minimum. Two ground conductors per line are provided, as well as tower counterpoise, where ground resistance is more than 20 ohms, to minimize the effect of lightning.

Impedance-type directional line relays are used, supplemented by carrier bypass to obtain instantaneous clearing at both ends of the whole section between terminals. Phase-to-phase and phase-to-ground relays overlap in function to provide mutual back-up protection.

For fast and reliable communication necessary for good control, a million-dollar multichannel microwave system is used with terminals at Bersimis, Quebec, and Montreal. There are seven repeater stations between Bersimis and Quebec and four between Quebec and Montreal, all of which have stand-by diesels for emergency power supply.

Main dams are of the rock-filled type with impervious clay blanket. The Lac Cassé dam is 2,210 feet long by 200 feet high and the DesRoches dam is 1,322 feet by 210 feet high. Rock was readily found locally which could be quarried and crushed in order to give the sizes required for the respective semivertical layers. On each side of the clay, layers graduate in rock sizes from ¼ inch to 10 inches. Suitable impervious clay was found only after considerable search by experts. Four million cubic yards of rock and 500,000 cubic yards of clay were required.

While the powerhouse design follows usual practice for underground powerhouses, it may be noted that the rock cover exceeds 150 feet; transformers are outdoors, fed by 6,000-ampere busses from each generator; straight-flow-valves, 93 inches in diameter for each unit, are designed for 540-psi service and 20-second closure; cooling water supplied by eductors instead of pumps is one of the steps in avoiding dependence on station service power supply.

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Nuclear Power Plant Instrumentation

R. C. FAUGHT, JR.

In the past five years, rapid advances have taken place in the field of nuclear power plant instrumentation. The emphasis in this article is placed on the power plant systems and on detector requirements and designs, because it is in these areas that the major differences exist between conventional and nuclear power plants.

INSTRUMENTATION for a nuclear power plant is not unlike that for any other power plant except for certain factors, most of which are present to a degree in conventional power plants. This discussion will be confined to the instrumentation of a reactor and large closed-loop heat transfer system, although many of the general design requirements for instruments will be applicable to a radioactive steam system.

The type of reactor and coolant system influence the type of instrumentation to be used. At present, operating nuclear power plants designed primarily for submarine propulsion are of two types: sodium-cooled and high-pressure water-cooled. Some of the sodium- and water-coolant system characteristics that influence instrument design are discussed in the following:

1. *Pressure.* A sodium-cooled system can operate at low pressure because of the high boiling point of sodium, whereas the water-cooled system must operate at several thousand psi (pounds per square inch) in order to achieve temperatures sufficient for reasonable thermal efficiencies. Pressure-measuring instruments, obviously, are directly affected by this condition. A secondary effect of high system pressure is the difficulty in designing fast response temperature detectors, which must have the necessary mechanical strength to contain the high pressure.

2. *Temperature.* The higher operating temperature in the sodium system greatly influences instrument design when it is coupled with another characteristic of sodium systems. This is the tendency of dissolved impurities (principally sodium oxide) in the sodium to deposit in the colder portions of the system. To overcome this difficulty and prevent plugging of sensing lines, devices such as pressure transmitters are mounted directly on the coolant system piping and must be designed to operate at coolant system temperatures. In water-cooled systems, pressure transmitters need not be mounted directly on the main system and need to be designed for only moderate temperature operation.

3. *Decay of Induced Activity.* As explained before, the coolant, either sodium or water, becomes radioactive in passing through the reactor by the capture of neutrons. Water activity, however, decays more than 6,000 times as fast as sodium activity. After the reactor has been shut down, the water-cooled system offers accessibility for maintenance and repair in a much shorter time than does the sodium system. A requirement for maintenance of instrument detectors on the coolant system, although not desirable, is much more feasible with the water-cooled system. It might be well to mention here that impurities in either the water or sodium coolant play a large part in the amount of coolant-induced activity and its rate of decay. If significant amounts of atoms that produce long-life isotopes are suspended or in solution, the rate of coolant activity decay will be decreased and accessibility restricted.

4. *Corrosion.* Both sodium and high-temperature pressurized water are corrosive fluids. The 18-8 stainless steels have, in general, been found to be satisfactory materials in contact with these coolants.

5. *Reactor Temperature Coefficient.* In a reactor, the neutrons liberated by a fission have high velocities and must be slowed down or moderated to a velocity suitable to cause the fission of another atom of the fuel. Moderators are materials containing atoms of low atomic weight comparable to the mass of a neutron. Moderation in a sodium-cooled reactor does not depend to any great extent on the sodium. The hydrogen in water, on the other hand, is a good neutron moderator and exerts a large influence on reactor reactivity. The degree of coolant moderation depends on the total number of water molecules in the reactor core as determined by the coolant volume and its density. The density is directly related to the average coolant temperature in the core. A reactor is said to have a negative temperature coefficient of reactivity when the reactivity decreases as the core temperature increases. Thus, the water-cooled reactor is inherently self-regulating and may be controlled principally by controlling average coolant temperature in the core. Temperature in the sodium-cooled reactor does not cause such large changes of reactivity and, hence, is not used directly as a principal control.

6. *Margin to Boiling.* Boiling in a reactor designed for liquid coolant heat transfer is undesirable, because the fuel elements may reach dangerously high temperatures as the result of the high heat flux and the lack of good heat transfer to the coolant. Sodium has a high boiling point, thus permitting coolant temperatures in the reactor to be well below the boiling point. In order to achieve good thermal efficiencies in a water-cooled reactor, reactor temperatures approach the boiling point of the coolant at several thousand psi operating pres-

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sure. The absolute values of system operating pressure and temperature in a water-cooled reactor system, therefore, become more important than those of a sodium-cooled system.

The margin to boiling and the reactor temperature coefficient of reactivity, as influenced by the coolant, are factors in determining how the system is controlled, what measurements are made, and how accurately the instruments must perform.

7. *Physical Properties.*

(a) *Melting Point.* The relatively high melting point of sodium requires means for heating pipes and equipment for initial charging of the coolant system, and adds to the number of surface temperature measurements required in the plant. The high melting point has been used to advantage in instrument designs to reduce the hazard of instrument failure. Small diameter tubing lines, for example, used in pneumatic pressure transmitters, can be run directly to the operating area without danger of the sodium's reaching the operating area should the system barrier in the transmitter fail. Should the system barrier rupture, the sodium will travel only a few feet before freezing and effectively sealing the line.

(b) *Thermal Conductivity.* The high thermal conductivity of sodium and low system pressure make the design of fast response temperature detectors easier than designs for high pressure water systems, with the poorer thermal conductivity of water.

(c) *Electrical Conductivity.* Probably the most outstanding property of sodium from an instrument design standpoint is its high electrical conductivity. This makes detectors for liquid level and flow possible by use of all-welded construction. These will be explained more fully later.

INSTRUMENTATION AND CONTROL

THE NUCLEAR REACTOR is the major piece of equipment in the nuclear power plant. The operation of the coolant system in transferring heat to the steam generator is dictated primarily by its effect on the reactor operation and safety.

Temperature, Neutron Flux, and Coolant Flow. The main factor to be controlled in the operation of a reactor is temperature. Excessive temperature will weaken the reactor structure, and severe thermal stresses can arise from rapid changes in temperature. If temperature could be measured instantaneously and in the right places in the reactor without disturbing its structure, the reactor could be controlled almost entirely from temperature.

Practically, temperatures cannot be measured instantaneously nor in the right places to effect the control of the reactor on temperature alone. Most reactor control systems are based on relatively slow temperature measurements in the coolant system plus a predicted steady-state temperature gradient in the core, plus a predicted transient temperature rise in the core. The coolant flow in the reactor core affects the predicted values of temperature gradient and transient temperature rise. In various plants the coolant flow may be fixed, variable in steps, or continuously variable as a function of reactor power.

Depending on the type of plant, the steady-state core temperature gradient can be predicted either from reactor neutron flux measurements or from measurements of coolant temperature rise and flow through the reactor core. The transient temperature rise can be predicted from either the rate of power change as determined from reactor period (a measure of the rate of neutron flux change) or coolant-flow-to-power mismatch.

In addition to the normal reactor plant control schemes, the reactor is protected by a safety shutdown system. For this purpose, the instrumentation and controlled variable must recognize the instantaneous reactor condition. Although other variables are often included in the safety system, the principal shutdown control is derived from neutron flux and rate of change of neutron flux. These variables provide protection from over-power and from too rapid increases in power.

Control Element Position. The mechanism of reactor control is to change the number of neutrons in the reactor core which can cause fission of the fuel. This is done either by introducing a material into the reactor which will capture neutrons or by changing the number of neutrons which can escape from the core by inserting a material which will reflect neutrons into the escape path. The position of these control elements is important in the operation of the reactor, and this position must be measured and indicated accurately. Control element position with the reactor operating at power is a measure of the general condition of the reactor as to the amount of fuel remaining and the degree of poisoning by fission products. It is very useful in subsequent start-up and fuel-loading operations to know at what control element position the reactor becomes critical.

Core Temperature Distribution. Reactor core temperature distribution measurements are useful in adjusting control element positions to obtain uniform power generation in the core and minimize high local temperatures.

Coolant System. In a water-cooled reactor, the coolant system pressure determines the temperature margin from the hottest reactor core surface temperature to the coolant boiling point. The measurement and control of coolant system pressure is, therefore, an important variable.

The coolant system pressure in a sodium-cooled reactor, although measured, is not as important a variable as coolant pressure in the water-cooled reactor, because the temperature margin to the boiling point is not so critical.

The liquid level in both the sodium and water coolant system expansion tanks is measured to determine that (1) sufficient supply of coolant is available, (2)

sufficient expansion space for surges is available, and (3) no gross coolant leakage has occurred to cause loss of level.

Coolant purity affects induced coolant activity. The purity is usually measured to determine whether maximum tolerances are in danger of being exceeded.

The reactor coolant systems are radioactive, and many precautions are taken to prevent leakage. In addition to these preventative steps, the coolant system and the various plant areas are monitored to provide warning alarms for any dangerous leakage of radioactive materials. The monitoring consists in part of neutron- and gamma-radiation detection plus detection of airborne radioactive particles.

GENERAL DESIGN CONSIDERATIONS

THE REACTOR AND COOLANT SYSTEM characteristics which have been discussed point the way to some general design considerations for instrumentation in a nuclear power plant.

Radiation. Radiation associated with the reactor and the coolant system is the major difference between a nuclear power plant and a conventional plant. There are three principal types of radiations present: (1) neutron flux, consisting of neutrons of various energy moving in random directions; (2) beta radiation, consisting of high-speed electrons; and (3) gamma radiation, consisting of high-energy electromagnetic radiation of wavelength shorter than X rays. The beta radiation is of relatively little importance, inasmuch as it is not very penetrating.

These radiations are present at high intensities in the reactor core and consist of neutrons from the fission process, beta and gamma radiation released promptly from the fission, and beta and gamma resulting from the gradual decay of fission products and induced activity of the coolant and reactor structure.

In the area outside the reactor core, the gamma activity caused by decay of induced coolant activity is high, but neutron flux mainly resulting from leakage from the reactor core is relatively low.

One of the chief effects of neutron and gamma radiation on instrument design is the effect on the choice of materials. Organic materials, in general, do not withstand irradiation well. Electrical insulations in critical areas where the radiation level is high are usually the inorganic oxides, alumina and magnesia, which will successfully withstand irradiation.

Radiation, principally neutron flux, can cause calibration changes in detectors. Resistance temperature detectors, for example, when exposed to high neutron fluxes, show an increase in resistance. The effect of neutron flux on metallic materials is similar to that of work-hardening and usually can be removed by annealing.

As noted previously, certain atoms exposed to high neutron flux become activated by capturing neutrons. This is important in the design of instrument detectors for use in the high neutron flux region of the reactor core. The detector with poor material choice may become highly activated with long-life isotopes and make removal of the detector for replacement difficult if not impossible. Not only the prime material choice, but also the permissible impurity levels in the chosen material are affected by this consideration. Stainless steels which exhibit low corrosion rates with the coolant and which have low tolerance on cobalt are generally used in reactor service. Special cleanliness precautions are observed, so as not to introduce impurities into the coolant system which could become activated in subsequent passage through the reactor core.

Integrity of the Coolant System. In view of the radioactive nature of the coolant, it is highly desirable to have no leakage in an instrument detector. Gasketed seals or packing glands are considered undesirable as a final system seal. The final seal usually is a metallic weld. In addition, the practice has been to provide two barriers to coolant leakage in series, wherever possible.

Reliability of Detectors. Reliability of instrument detectors is an important requirement of nuclear power plants. Although the radioactive coolant system may contain protective devices, such as overpressure relief valves, it is highly desirable that the control instrumentation restore the plant to normal conditions without venting radioactive coolant. The operational failure of a detector may cause a plant shutdown. Because of the nature of the plant, shutdown time is more costly and the time for replacement of equipment is longer than in conventional plants. Failure of the detector in such a way as to cause failure of other components in the plant, for example, the introduction of debris in the coolant flow passages of the reactor, is highly undesirable.

It is the practice to install spare detectors for critical measurements. These detectors may be in operation continuously, as in an auctioneer circuit which selects the highest indication from a number of detectors, or the spare detector may be wired to an accessible location in order that the spare may be substituted by a wiring change if the normal detector should fail.

The cost of extreme detector reliability and long life is easily justified in view of the cost of detector failure.

Accessibility and Remote Maintenance. Accessibility for replacement or repair is a desirable goal in choosing detector design and location. However, it is often difficult to achieve. The reactor and the entire coolant system are surrounded by radiation shielding. No personnel access is possible within this shielding during power-plant operation. Access after plant shutdown is limited by the decay of reactor core fission products and induced coolant activity.

Several design philosophies result from these considerations. First, increased complexity of equipment and circuitry is accepted outside the shield, so that detectors of simple reliable design requiring no maintenance can be installed within the shield. Second, remote calibration means are incorporated in the design, where feasible, to determine zero shift and sensitivity changes of the detector.

The shielding structure also acts as a barrier to pre-

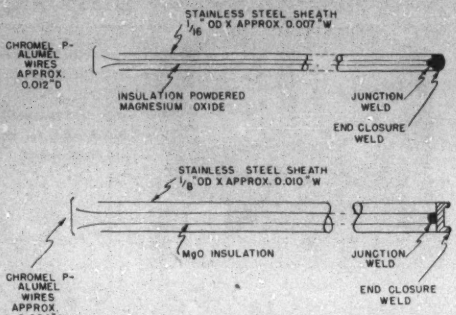

Fig. 1. Sheath-type chromel–alumel thermocouples, 1/16-inch and 1/8-inch OD.

vent contamination of the area outside the shield by any possible leakage of radioactive coolant. The instrument detector design within the shield must permit satisfactory sealing of the signal lines penetrating the shielding.

Because shielding a large area is expensive, it is desirable to provide a radioactive system of minimum size. This has the effect of minimizing the space available for instrument detectors, of making detector accessibility difficult and of providing poor approach conditions for such measurements as flow. In nuclear propulsion plants, the size of the shielded area is even more critical and may make the difference between a feasible plant and an unfeasible plant. Size and weight of instrument detectors for use in a propulsion plant should be the minimum consistent with reliability and long life.

Detector Ambient Environmental Conditions. Detector ambient environmental conditions, other than those already discussed, do not differ widely from those of conventional plants. Ambient temperature may be slightly higher inasmuch as ventilation is restricted by shielding considerations. Ambient pressure may be slightly lower than atmospheric pressure so that shield leakage is into rather than out of the possibly contaminated area. In the case of the sodium coolant system, an oxygen-deficient atmosphere may be provided to minimize the fire hazard should a sodium leak occur.

ADDED CONSIDERATIONS FOR PROPULSION PLANTS

THE REQUIREMENTS to be met by instruments for nuclear propulsion plants, especially submarine propulsion, are more severe than those for land-based nuclear power plants. In addition to the considerations previously discussed, the requirements for instruments in submarine service include ability to meet shock, vibration, attitude inclination to 60 degrees, high humidity, and wide voltage and frequency regulation in the power supplied.

The requirements of submarine service restrict the choice of instrument intermediate and end devices to types that meet shock and vibration adequately and have, in addition, a long life with a minimum of required maintenance. Magnetic amplifier devices are considered superior to vacuum tube amplifier devices in these respects. This fact tends to restrict the choice of primary detectors to those exhibiting relatively high signal outputs which may be used reliably with magnetic amplifiers. Transistor amplifiers are not yet in wide use for reliable submarine service, although their use is being accepted in more and more applications.

Providing a clean, dry, control air supply on a submarine is difficult, and pneumatic instruments are subject to excessive maintenance. Electrical types, therefore, are preferred for submarine service.

EXAMPLES OF SPECIFIC INSTRUMENT DESIGNS

Temperature. Fig. 1 shows sketches of 1/16-inch and 1/8-inch OD stainless steel sheath, magnesium oxide insulated, chromel-alumel thermocouples designed for direct immersion in the core of a sodium-cooled reactor for temperature distribution measurements.

To avoid open-circuit failures at the junction, the junction welds should not be held by the closure weld. The time constants (63%) with the junction welds not in contact with the closures are of the order of 1 second for the 1/16-inch and 1½ seconds for the 1/8-inch couples. This type of couple is available in lengths up to 24 feet. The sheath is flexible, and these couples can be used in thermowells made from small bore tubing, as well as for direct immersion service.

Resistance thermometers provide better accuracy than thermocouples and can be readily arranged in a

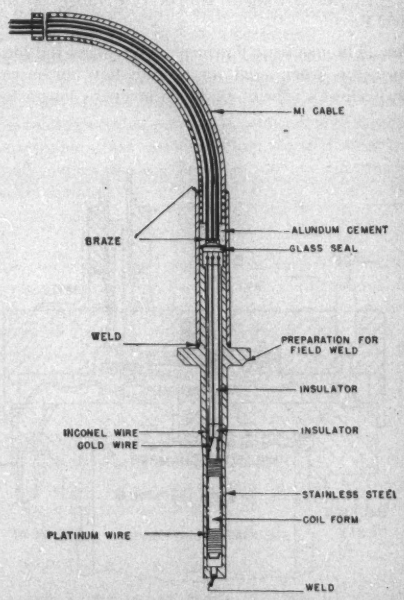

Fig. 2. Resistance thermometer for liquid metal service.

bridge to give high signal outputs indicating temperature, average of two temperatures, or difference of two temperatures. Resistance temperature detectors are usually used for coolant temperature measurements.

Fig. 2 shows a cross-section of a 25-ohm (at 32 F) platinum resistance temperature detector designed for direct immersion in a radioactive sodium coolant system with moderate neutron flux exposure. The detector has a time constant (63%) of less than 3½ seconds and an accuracy of ±1½ F at temperatures up to 1,000 F. The design shown meets submarine service requirements.

Pressure. Fig. 3 shows a cross-section of a double-diaphragm pressure transmitter designed for submarine service and also to meet the requirements for measuring radioactive sodium coolant pressure. Freezing and plugging difficulties in measuring sodium pressure are overcome by mounting the transmitter directly on the system piping. The null force balance transmitter overcomes problems of temperature compensation which may result from changes in spring constant, because only small displacements of the diaphragm are required for balance. The ratio between diaphragm areas allows an air supply pressure less than the coolant system pressure and the interdiaphragm space allows a remote check of operation and also the possibility of measuring pressures less than atmospheric by preloading.

A double barrier is provided for leak protection, and the freezing properties of sodium in small lines is used in the event of diaphragm rupture to prevent contamination of the operating area. The accuracy of these units is ±3% for a coolant temperature range of 300 to 1,000 F.

Flow. The magnetic flowmeter approaches the ideal in flowmeters when used for sodium flow measurement. Fig. 4 shows a view of an 8-inch magnetic flowmeter for

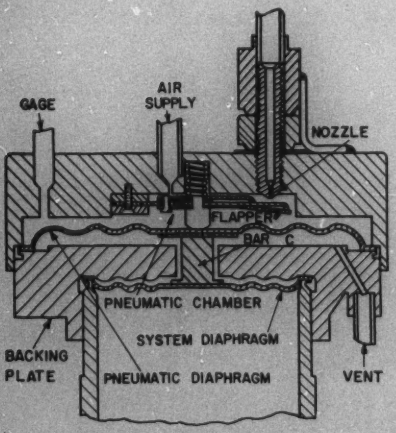

Fig. 3. Pressure transmitter.

Fig. 4. Flowmeter, 8-inch type, for liquid metal service.

sodium service. The high electrical conductivity of sodium relative to the pipe wall material permits electrode attachment on the outside of the pipe wall; hence, no system penetration is needed. This type of flowmeter has the additional advantages of (1) negligible system pressure drop, (2) operation over wide temperature and flow ranges with relatively linear volume flow output signals, (3) relative insensitivity to approach conditions, (4) rapid response, and (5) the fact that calibration may be calculated from pipe materials, properties, dimensions, and measurements of air gap flux density. For the 8-inch flowmeter shown, the output signal for a flow of 3,000 gallons per minute would be 30 to 40 millivolts and could be read on conventional potentiometer and pyrometer instruments such as those used with thermocouples.

A magnetic flowmeter is not completely insensitive to temperature, inasmuch as the air gap flux and conductivities of the pipe material and sodium change with temperature. In large flowmeters, linearity at high flows is affected by the ratio of pole face length to air gap width and, to some extent, by approach conditions. Care also must be taken to insure that thermal electromotive forces are not induced in the signal leads.

Liquid Level. Fig. 5 shows the cross-section of a bottom-mounted resistance-type liquid level detector designed for submarine service with radioactive sodium. The detector makes use of the high electrical conductivity of sodium which progressively short circuits the probe resistance as the level rises. The total resistance change is of the order of 0.002 ohm. The design provides an all-welded construction in contact with sodium, as well as a simple construction requiring no maintenance. Automatic temperature compensation is provided, as is a reference signal for check of the measurement circuit.

Neutron Flux. Reactor neutron flux measurements are made to determine the instantaneous reactor power and the rate of power change for reactor start-up operation, because coolant system temperatures and flow provide little information about the reactor condition below the power range. The reactor condition can be predicted from a knowledge of control element position, but the measurement of neutron flux provides the best indication of reactor power. For this reason, reactor neutron flux is usually measured over a range of 11 or

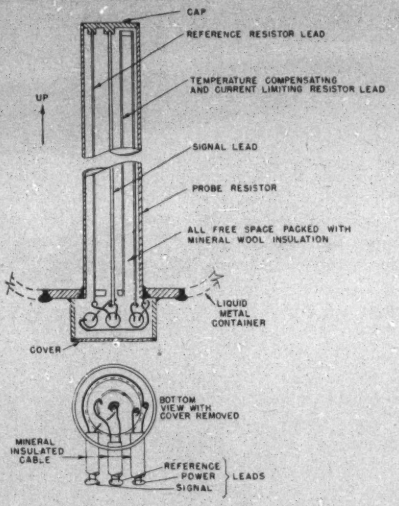

Fig. 5. Level detector, bottom mounted, for liquid metal service.

12 decades. To cover such a large range, three types of neutron-sensitive detectors are used.

Fig. 6 shows a sketch of a boron-lined proportional counter. This device makes use of the capture of neutrons by boron-10. Neutron capture by B-10 liberates lithium-7 and an alpha particle (ionized helium atom). The alpha particle, by collision, liberates electrons in the gas fill. These electrons are accelerated by a high-voltage gradient toward the collector wire and cause an avalanche of secondary ionization in the filling gas. The output of the counter tube is then a pulse of charge. Gamma radiation also can cause pulses, but these are discarded in the pulse-counting circuitry by discriminating against all pulses smaller than the size of a pulse caused by an alpha liberation. This type of detector is used in measuring the lower range of neutron flux. If gamma flux is sufficiently high, the detector will jam and cease to operate.

For high neutron flux, an uncompensated ion chamber, as sketched in Fig. 7 (A), may be used. The voltage gradient in this type of chamber is less than in the proportional counter, and the liberation of alpha particles by neutrons is used to ionize the filling gas to produce an ion current. Gamma radiation readily causes ionization in this type of detector. The signal output would still be proportional to reactor power if the ratio of the neutron-induced signal to the gamma-induced signal

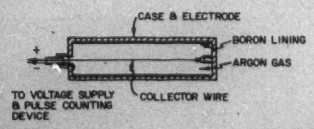

Fig. 6. Proportional counter.

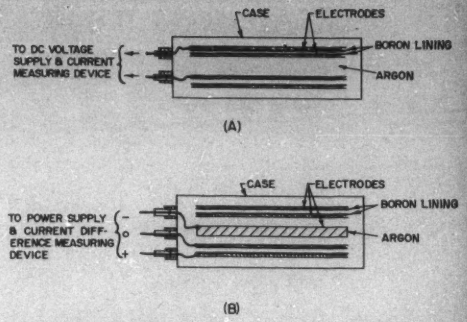

Fig. 7. (A) Uncompensated and (B) gamma-compensated neutron-sensitive ionization chamber.

were high or if the gamma radiation were produced promptly by the same fissions causing the reactor neutron flux.

Fig. 7 (B) shows a sketch of a gamma-compensated neutron-sensitive ionization chamber. The chamber consists of two equal volumes, both of which are sensitive to gamma radiation. One of these volumes contains a B-10 lining and, hence, is also sensitive to neutrons. If the ionization currents are bucked from each volume, the remaining signal will be from the neutron flux alone. Such a device cannot be compensated perfectly because of end effects and nonuniform fluxes. Shielding materials, such as lead, can be used to obtain an improvement in neutron-to-gamma flux ratios. Neutron flux will pass through lead with little attenuation, whereas gamma flux will be materially decreased.

Gamma-compensated neutron-sensitive ionization chambers are used for reactor power measurements in the intermediate neutron flux range where the gamma flux is too high for proportional counters and the neutron-to-gamma flux ratio resulting from fission and product coolant activity decay is too low for uncompensated chambers.

CONCLUSION

This discussion has been confined largely to nuclear power plant systems and to detector requirements and designs. This is believed appropriate because it is in these areas that the major differences exist between conventional and nuclear power plants. In the last five years, advances in the field of instrumentation for nuclear power plants have been rapid. This discussion represents only a small part of the published material on this subject.

Acknowledgment is given to E. P. Diehl of the General Electric Company meter and instrument department for material contained in an unpublished paper on this subject.

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An Analysis of D-C Machine Commutation

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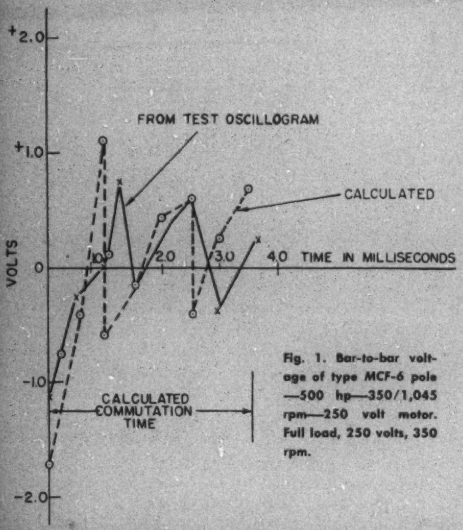

Fig. 1. Bar-to-bar voltage of type MCF-6 pole—500 hp—350/1,045 rpm—250 volt motor. Full load, 250 volts, 350 rpm.

THE D-C MACHINE is about the most complex piece of apparatus in the rotating machinery field, mainly because of the challenging problem of commutation. In the present age of driving d-c machines to ever greater output, the necessity for a thorough understanding of the nature and causes of brush sparking has become of paramount importance.

Many criteria have been suggested as a measure of commutation; among these are reactance voltage (the total inductive voltage induced in a coil undergoing commutation and bar-to-bar voltage during commutation. In 1952, T. M. Linville and G. M. Rosenberry, Jr. presented an AIEE paper entitled "Commutation of Large D-C Motors and Generators." The authors showed the application of a general and powerful method for calculating reactance voltage, bar-to-bar voltage during the commutation, and compensating voltage (voltage supplied by commutating pole for perfect commutation) as applied to one machine. The present paper is an extension of the previous work to provide the organization of equations and curves necessary to calculate the aforementioned voltages for lap-wound machines having up to six conductors per slot and any brush overlap.

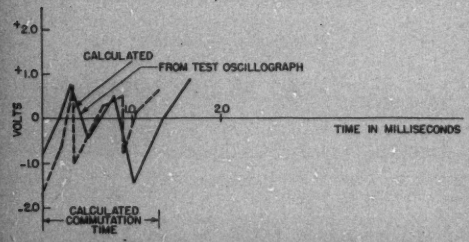

Fig. 2. Bar-to-bar voltage of type MCF-6 pole—500 hp—350/1,045 rpm—250 volt motor. Full load, 250 volts, 1,045 rpm.

In the past, d-c machine designers have been wary of laborious analytical methods of predicting commutation performance caused by the lack of tools to complete the calculations in a reasonable period of time. However, with the advent of the high-speed stored-program digital computers, such attitudes need not prevail. The method of analysis presented in this paper was applied to several d-c machines with the aid of a digital computer, use of which made it possible to complete the calculations in a relatively short period of time.

Figs. 1 and 2 are the test and calculated bar-to-bar voltage results for a 500-hp motor at base speed and top speed respectively. Even on this motor, which was supposedly properly adjusted, the normal condition of operation is to have severe pulsations of bar-to-bar voltage during commutation.

CONCLUSIONS

THE METHOD OF ANALYSIS presented is capable of predicting the shape of the bar-to-bar voltage curve during commutation with a relative degree of accuracy. Peak values of bar-to-bar voltage during commutation are suggested as the limiting criteria for acceptable commutation because even machines having so-called acceptable values of reactance voltage are subject to severe bar-to-bar voltage pulsations that may cause brush sparking.

Reactance voltage, commutating pole compensation, and coil current shape are determined as by-products of the analysis for bar-to-bar voltage. For the designer who considers any of these factors as limits of commutation, the present paper should be of value. It should be borne in mind, however, that only with the aid of the high speed digital computer does the numerical computation of the present paper become practical. Programs representing the analysis may be formulated so as to determine the aforementioned calculated criteria for comparison with test data.

Digest of paper 57-123, recommended by the AIEE Rotating Machinery Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Published in AIEE *Power Apparatus and Systems*, pt. 3, Aug. 1957, pp 399-416.

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Analysis of Simultaneous Line-to-Ground Faults

G. I. STILLMAN
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A CERTAIN PERCENTAGE of the faults on power systems occur simultaneously at different points in the circuits. Such faults may result from a ground at one location on a circuit which raises the voltage on a healthy phase so that a flashover occurs at a second location. Such faults may also occur on circuits which are physically close to each other, as two circuits on the same poles which flash over because of the same lightning disturbance. It has been estimated that up to 20% of faults on double-circuit lines involve conductors of both circuits.

Equations are derived which result in universal curves of fault currents and voltages for two separated line-to-ground faults on two different phases of the same circuit, or two parallel circuits, connecting two points on a given system. Such curves obviate the need for extensive calculations or board studies to find the currents and voltages for simultaneous faults.

It is assumed that the actual system can be simulated by an equivalent two-machine system (Fig. 1). Both ends of the line are assumed to be solidly grounded so that, for lines of uniform construction, the zero sequence impedances as well as positive and negative sequence impedances will be proportional to the lengths of line over which they are considered. Faults occur at points x and y. Fault resistances are assumed to be zero. The impedance between the y fault and source 2 is considered to be a constant k_1 times the impedance between source 1 and the x fault. The impedance between the x fault and y fault is taken to be a constant k_2 times the impedance between source 1 and the x fault (Fig. 1). The

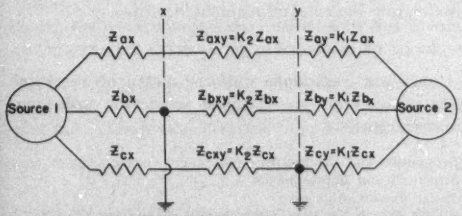

Fig. 1. Two-machine equivalent of system under study.

fault voltages and currents are plotted versus system reactances with these constants as parameters. Currents are expressed as a ratio to the three-phase short-circuit current at the source 1 end (Fig. 2). Voltages are from line-to-ground and are expressed as a ratio to normal line-to-neutral voltage.

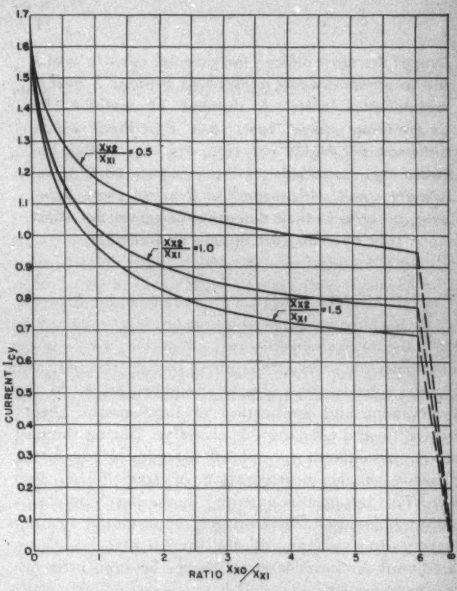

Fig. 2. $k_1 = 5.0$, $k_2 = 0.2$ for I_{cy}. Current values should be multiplied by 5.0 to be expressed as ratio to 3ϕ s-c current at point y and by 1.0 to be expressed as ratio to total 3ϕ s-c current at point y.

CONCLUSIONS

The curves show that fault currents for simultaneous line-to-ground faults may be more than eight times the three-phase short-circuit contribution from the source closest to one of the faults (Fig. 2). On a total three-phase, short-circuit current basis, however, the values are of the same order of magnitude as for single line-to-ground faults for small values of X_{z0}/X_{z1} and may be over twice as great for high values of X_{z0}/X_{z1}.

Because the system is considered to be solidly grounded at both ends in this paper, the fault voltages on the healthy phases do not exceed a value of 1.73 times the normal line-to-neutral voltage. It is known, however, that for single line-to-ground faults which are resistance grounded, fault voltage may rise to twice the normal line-to-neutral voltage.

The final equations derived need but little work to make them suitable for solution on a digital computer for many more conditions than are included herein.

Digest of paper 57-671, recommended by the AIEE System Engineering Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Montreal, Que., Canada, June 24-28, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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Incremental Maintenance Costs of Steam–Electric Generating Stations

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One of the most difficult incremental costs to evaluate in steam–electric generating stations is that of maintenance costs. A number of methods for determining these costs are described which, although not highly accurate, are very useful. Because the magnitude of maintenance costs is relatively small with respect to over-all costs, however, an error in their determination does not affect the over-all cost figures appreciably.

ONE MAJOR OBJECTIVE of economic load dispatching is the production of electric energy at the lowest possible cost consistent with the requirements for service reliability. During the past two decades, considerable progress has been made in the development and application of fundamental theory directed toward effecting this objective. During the past decade, refinements have been introduced, consisting primarily of the incorporation of transmission line losses. This has been augmented by the development of computers for use in determining the economic loading of generating stations and the incremental costs associated with the interchange of energy between interconnected systems.

With respect to fuel-burning steam plants, production costs include (1) fuel, (2) maintenance, (3) labor, and (4) supplies. Of these, fuel and maintenance will be affected most by a change in generation. Labor is not generally an element of incremental production cost unless the equipment in service is changed. When this takes place, the associated labor cost is determined as a constant element independent of the change in generation. The cost of supplies is affected to a negligible extent, and for all practical purposes may be omitted as an element of incremental production cost.

The distribution of production costs is shown in Fig. 1 for the Class A and B privately owned companies, as reported by the Federal Power Commission (FPC) for the 19-year period from 1937 through 1955.[1] The distribution of production costs based on weighted averages for the period, are indicated to be

Fuel	72.8%
Labor and Supplies	15.3
Maintenance	11.9
Total	100.0%

With fuel as the major element of production cost, it is understandable why it is desirable to determine the incremental fuel costs with a high degree of precision, which is obtainable when adequate test facilities are available. With respect to determination of incremental maintenance costs, the general attitude differs somewhat. It is best expressed by the following quotation from a recent paper[2] which is devoted in part to the accuracy requirements of incremental production cost data:

> "One of the elements of incremental production cost most difficult to evaluate accurately is the incremental maintenance cost. Various approaches to this problem have been tried, but due to the time interval between the event contributing to a condition requiring maintenance, and the actual maintenance expenditure, none of them has proved completely acceptable. However, on the AGE [American Gas and Electric Company] system, the magnitude of incremental maintenance cost in comparison with incremental fuel cost is relatively small (10% or less), so that a rather large error in incremental maintenance cost would result in a minor loss of economy due to the resulting misloading."

Although it is possible to establish with acceptable precision the hourly fuel costs expressed as a function of the kw load generated, from which the conventional incremental unit fuel cost data can be derived, no acceptable method has as yet been developed for establishing a similar relation for maintenance costs. It has become, therefore, almost the universal practice to estimate incremental maintenance costs as a matter of judgment, the exercise of which is based, to a large extent, on prevailing maintenance costs as carried on the books of account. It is the purpose here to offer some comments on the use of statistical cost data for the purpose of approximating incremental maintenance costs.

ACCOUNTING RECORDS OF MAINTENANCE COSTS

UNDER THE PRESCRIBED uniform system of accounts, maintenance costs are classified under the following broad categories:

Supervision and Engineering
Structures and Improvements
Boiler Plant Equipment
  Coal storage, handling and weighing equipment
  Furnaces and boilers
  Boiler apparatus
  Steam piping and accessories
Generating and Electric Equipment
  Prime movers and generators
  Accessory electric equipment
Miscellaneous Power Plant Equipment

Essentially full text of paper 57-1060, presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, 1957. Recommended for publication by the AIEE Power Generation Committee.

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Under this format, it is the general practice to provide an accounting system with subaccounts to permit distribution of maintenance costs among specific classes of equipment against which the costs are chargeable. It has been possible to extend accounting statistics considerably with the availability of large-scale electronic data-processing machines. One company reports[3] that monthly tabulations are made of some 200 separate maintenance accounts for each major plant. Such records permit extensive analyses of cost trends which are used to measure the effectiveness of methods to reduce maintenance costs,[2] for the determination of the economic need for design modification of existing equipment and planned additions, and for establishing company maintenance policy.[4]

The use of accounting records of maintenance costs require some caution. Extraordinary nonrecurring maintenance expenditures should be excluded, as should expenditures for maintenance associated with capital expenditures, inasmuch as these are not elements of incremental maintenance costs. To minimize the effect of deferred maintenance, costs averaged over a period of years, say 5 years, is recommended.

In the section following, several methods of utilizing records of annual maintenance costs are described without comment on their relative merits. It is expected that methods other than those described may be in use.

METHODS OF CALCULATION

In the absence of any exact method for determining incremental maintenance costs, the simplest solution of the problem would be to assume that the incremental unit maintenance costs is the same as the average unit maintenance cost. This could be justified on the basis that maintenance costs represent a relatively small percentage of the total production costs, or when a statistical analysis indicates a negligible variation in the average unit maintenance costs with variation of generation. In the latter case, it is elementary theory to state that if the average unit costs for two levels of generation are equal, the corresponding incremental unit cost is equal to the average unit cost. This is demonstrated as follows:

Let $A = A_1 = A_2$, the average unit cost at levels of generation E_1 and E_2, A_i = the average incremental unit cost for a change of generation from E_1 to E_2. Then

$$A_i = \frac{A_2E_2 - A_1E_1}{E_2 - E_1} = \frac{A(E_2 - E_1)}{E_2 - E_1} = A \qquad (1)$$

A refinement of this method would be to exclude maintenance costs for equipment which are known to be unaffected to any appreciable degree by variation in generation. This would eliminate all items of equipment except boiler plant, which includes fuel and ash-handling equipment, boilers and furnaces, boiler apparatus, steam piping and accessories, and an allocated portion of accessory electric and miscellaneous power plant equipment. Application of this approach to one system was described in 1938.[5] The influence of various factors on the maintenance of components of plant

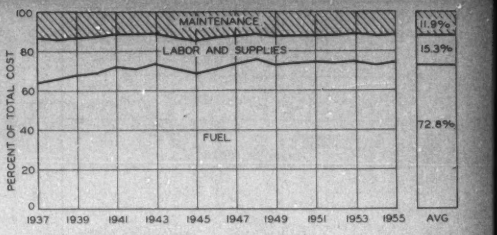

Fig. 1. Per-cent distribution of production costs for thermal–electric plants, Class A and B privately owned utilities.

equipment is shown in Table I. The "yes" items under columns A, B, and C can be grouped to represent the component of cost, applicable when a change in generation involves a change in the combination of equipment in service. Column D can be considered as that component of cost which is affected by changes in generation only, and it is noted that the only item involved is the maintenance of boiler plant equipment.

An analysis of maintenance costs[6] for 10 large power pools for the 8-year period from 1948 through 1955 shows some interesting trends which are indicated in Fig. 2. Distribution of total maintenance costs into components of boiler plant, turbogenerator and electric plant, and structures remained constant notwithstanding a capacity increase of 125% above the value at the beginning of the 8-year period. The impact of the advancement in the art of design is reflected by the respective indexes for total and boiler plant unit maintenance costs. The effect of type of boiler fuel on boiler

Table I. Maintenance Items Affected by Various Factors

	A	B	C	D
	Plant Capacity, kw	Actual Peak Load Provided For, kw	Hours per Day Peak Load Prepared For	Generation, kw-hr
Boiler plant equipment	Yes	Yes	Yes	Yes
Turbogenerator equipment	Yes	Yes	Yes	No
Electric generating equipment	Yes	Yes	Yes	No
Accessory electric equipment	Yes	Yes	Yes	No
Miscellaneous power plant equipment	Yes	Yes	Yes	No
Power plant structures and grounds	Yes	No	No	No

plant maintenance costs is shown in Fig. 3. Each curve reflects the cost experiences of a specific power pool utilizing a single type of fuel. The burning of different types of fuel in combination or at different times results in maintenance costs which vary between the upper limit shown for coal and the lower limit shown for gas, depending upon the combination of fuels and quantity of each type burned.

The assumption that the incremental unit maintenance cost is equal to the average unit maintenance cost would not be valid in most instances. The average unit cost is subject to breakdown between "demand" and

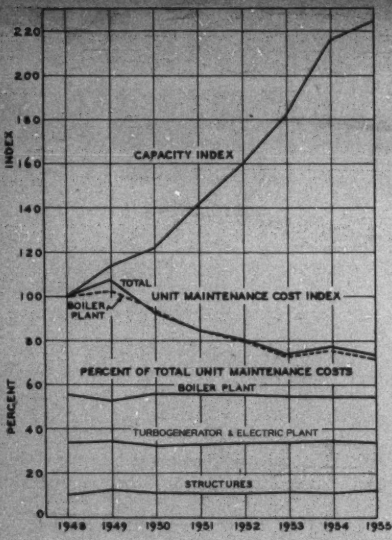

Fig. 2. Distribution of maintenance costs for 10 power pools.

"energy" components, or "fixed" and "variable" components, with the latter generally considered as the incremental unit cost. A review of the available literature indicates two methods for determining the breakdown between the two components. One is arbitrary, involving the exercise of judgment, a typical illustration of which is the breakdown suggested by Justin and Mervine,[7] shown in Table II. The other method is based upon some extensive mathematical analysis by Funk and Ralston.[8] A linear relation between annual costs in dollars, and annual generation is established. The no-load intercept is considered as the fixed or demand component of cost. The slope of the straight line gives the incremental unit cost. To reflect the effect of plant capacity and the peak prepared for, the no-load component of annual cost is subdivided into two components so that a linear equation is established as

$$A = K_1 + K_2 + K_3 \text{ (kw-hr)} \qquad (2)$$

where

A = annual cost, dollars
K_1 = component of annual cost related to capacity, dollars
K_2 = component of annual cost related to peak prepared for, dollars
K_3 = incremental unit cost, dollars per kw-hr

Use is made of this method to establish an average incremental unit maintenance cost which is considered independent of the incremental unit fuel costs. It is included as a constant element of total incremental cost.

Table II. Division of Production Cost by Percentages

	Fixed Cost, per cent	Variable Cost, per cent
Operation		
Superintendence	70	30
Boiler labor	60	40
Engine labor	100	0
Electric labor	70	30
Other labor	70	30
Fuel	15	85
Sale of ashes	15	85
Water	25	75
Lubricants	70	30
Boiler plant supplies	55	45
Boiler plant expenses	55	45
Other power plant supplies	55	45
Other power plant expenses	55	45
Superintendent's and other employees' expenses	70	30
Maintenance		
Power plant structures	100	0
Railroad sidings and trestles	50	50
Boiler plant equipment	55	45
Steam engines and turbines	55	45
Turbogenerators	55	45
Other electric generators	80	20
Other electric equipment	80	20
Coal storage and weighing equipment	50	50
Other power plant equipment	55	45

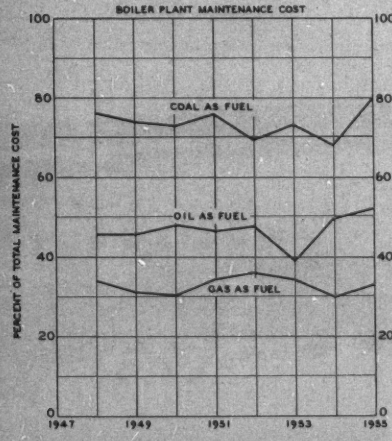

Fig. 3. Effect of type of fuel on boiler plant maintenance costs.

Analysis of annual cost data supports the inference that maintenance costs are not constant, but vary with fuel costs. This is illustrated by Fig. 4, which was derived from statistics for the entire industry as published by the FPC for the years 1937 through 1955. Although the relation between incremental maintenance and fuel costs is not capable of exact determination, it can be approximated as previously described.[9] Briefly, annual costs for fuel and maintenance are established graphically as linear functions of annual generation. The slope of the annual maintenance cost curve divided by the slope of the annual fuel cost curve is assumed as the ratio of incremental maintenance costs to the incremental fuel costs. Because both the annual fuel and maintenance costs are represented as linear functions of annual generation, the annual maintenace costs can be established as a linear function of the annual fuel costs

directly. The slope of this curve is then assumed to be the ratio of the incremental costs. The results of this method, applied on a nation-wide basis to the thermal electric plants of the Class A and B privately owned utilities, are illustrated in Fig. 5. The results are of academic interest only, in view of the many variables involved. It demonstrates, however, that the statistical annual fuel and maintenance costs for the industry as a whole, when adjusted to a common price level, will plot to indicate a linear relation between the two.

The allowance for incremental maintenance cost generally varies between 5% and 30% of incremental fuel costs, depending upon the class of equipment involved, type of fuel, and range of equipment loading. A survey of current practices in regard to determination of incremental maintenance costs would be beneficial to the industry and is, therefore, recommended.

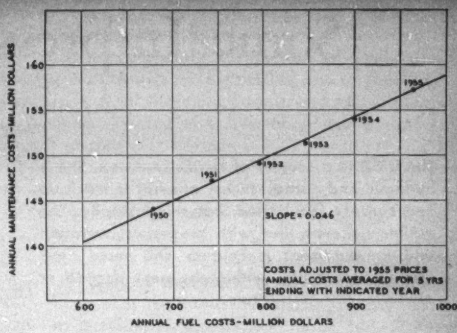

Fig. 5. Ratio of incremental maintenance cost to thermal electric plants, Class A and B privately owned utilities. Costs adjusted to 1955 prices.

CONCLUSIONS

ALTHOUGH fuel costs can be established as a function of the kw load generated with acceptable precision, no method has as yet been developed to permit determination of a similar relation for maintenance costs. Incremental maintenance costs are determined as a matter of judgment, based on past annual cost experience. This is justified by the relatively small ratio of maintenance costs to total production costs. Annual costs of accounting record can be utilized to establish incremental maintenance costs at a fixed unit value per kw-hr, or as a fixed percentage of the incremental fuel costs. On either basis, the precision of the derived values of incremental costs will be indeterminate. A survey to determine current practices in regard to determination of incremental maintenance costs is desirable.

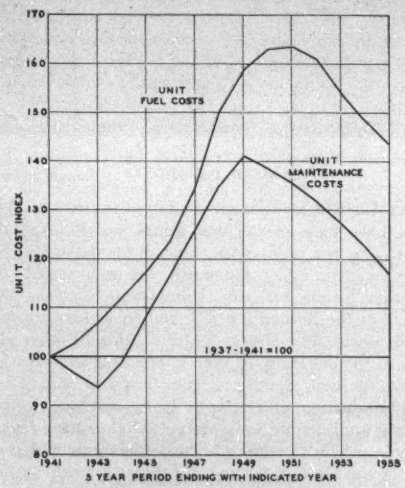

Fig. 4. Index of annual unit fuel and maintenance costs for thermal electric plants, Class A and B privately owned utilities.

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Vapor-Cooled Transformer

The world's first and only transformer in commercial operation utilizing high dielectric strength gas went into service in July 1957. Developed by Westinghouse Electric Corporation, Pittsburgh, Pa., it is a 500-kva vapor-cooled gas-insulated submersible unit operating on the network system of the Consolidated Edison Company of New York, Inc.

Vapor cooling of transformers was announced first by Westinghouse in the Fall of 1951. This network transformer utilizes a combination of a fluorochemical and sulfur hexafluoride as the cooling and insulating medium. These compounds not only are nonflammable, but also have fire-extinguishing properties.

Some Impressions of Russia

HENDLEY BLACKMON
FELLOW AIEE

The USSR is a country of terrific contrasts. She is dynamic and earnest in her attempt to catch up and surpass the United States industrially. The author believes that with proper organization and management techniques she could "explode" industrially within the next decade or two.

THE FOLLOWING are some impressions of Russia, based on what I saw and heard while attending a 2-week technical meeting in the Union of Soviet Socialist Republics (USSR). Please bear in mind that these are strictly personal impressions and make no claim whatever to being authoritative.

The meeting was the annual conference of the International Electrotechnical Commission (IEC), a worldwide technical body for developing acceptable voluntary standards for such fields as electric light, power, and communications. The IEC meeting was held in Moscow July 2-12, 1957. There were approximately 500 delegates, from 27 countries, including about 200 from the Soviet Union. I was a member of the American delegation, which totaled 32, including 10 wives. Sixteen technical committees met; and English was used in practically all of the sessions. The Soviet delegates were highly competent, polite, and spoke only via their chief delegates. They frequently supported the United States position, and accepted compromise as gracefully as the other delegates. The Moscow meeting produced 14 draft international standards, and in general was successful and productive.

All IEC delegates received the "red carpet" treatment right from the start. The Soviets were out to impress us —and in many ways they did. Customs were eased. We were housed in the 14-story, 500-room Hotel Moscow—their best, and the first time outsiders had been accommodated there. All meetings were held at the new and impressive 32-story Moscow State University that is visible from most anywhere in the city. Evening entertainment was lavish and top-grade, ranging from the ballet at the Bolshoi Theatre to a reception at the Kremlin by the Ministry of Power Stations. We roamed the city at will, without surveillance; took pictures anywhere, except from planes.

THREE FUNDAMENTALS

THREE FUNDAMENTALS will help to understand the USSR:

1. The Soviet Union is an exceedingly complex society with centuries of tradition and background vastly different from our own. For example, the masses have always had "bosses" starting with the first czar in 1547; they expect them, and accept their edicts without question.

2. The ordinary citizen compares his present way of life with that of his father or grandfather—not with what we have here in the United States. Compared to the miserable serfdom and illiteracy of their forefathers, the Soviet people today are immeasurably better off; and they regard the communistic system as their savior.

3. All Soviet citizens must live from their own personal labor. None may derive any income from work of others. Women must work until age 52; they are "emancipated" and have "equal opportunity and pay" with men. For example, they were digging ditches, carrying mortar up buildings, driving trucks, sweeping streets with twig brooms, hoeing fields, running cranes, carting cement by hand, etc. A citizen may own his house, poultry, pigs, etc., and sell at the market place products of his own labor. But he cannot use raw materials and hired help to obtain profit for himself. The State owns all the land, inventions, minerals, and the like.

LAND OF PARADOXES

THE USSR IS A FASCINATING LAND of terrific contrasts. They have some of the best things and some of the worst. The best may be few, but are unmistakable. For example, their ballet and music are unsurpassed. We saw their prima ballerina Ullanova in "Romeo and Juliet" at the Bolshoi Theatre and its artistry was out of this world. The Moscow "Metro" puts all other subways to shame. Many of their theoretical scientists are among the best; Sputnik is good proof of this. Their mass production of engineers is beyond our wildest dreams; and, despite wars, since 1917 they have taught a whole nation to read. They have fabulous museums, such as the Hermitage; and are the only people flying pure jet planes in scheduled commercial service. About 80 miles north of Moscow we were told is a 10 billion electron-volt cosmotron—the biggest atom smasher in the world. And finally, their natural resources appear to be unequalled by any nation on this earth. Of such are their good things.

The worst things are many—and everywhere. They have no freedom or justice as we know it and seemingly

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The author wants it stressed that these impressions are based on "catch-as-catch-can" conversations with various people during a short two-week stay, and his views should not be regarded as authoritative—they are simply an integration of his personal observations and beliefs. All delegates were in the hands of Intourist; so, in general, saw only those things and met only those people that were selected. Mr. Blackmon attended the IEC meeting as vice-president of the United States National Committee of IEC and made side trips to Zaporozhye and Leningrad.

Fig. 1. Moscow University, founded 1755, is the oldest university in the Soviet Union.

precious little joy. They have poor housing; few household appliances; monotonous diet; shabby clothing, except for the children; fantastic prices for inferior goods (a 10 cent candy bar costs $1.48, a sizable orange $1.65); no news of the outside world—only propaganda; no personal feeling of responsibility toward influencing governmental affairs; 80% of the women work in the labor force; and there is no religion in the sense we know it.

Many things that we take for granted they know nothing of. For example, Soviet citizens have never: seen a comic strip or golf course; chewed gum; shopped by mail; played the stockmarket; paid a bill by check; or read a gossip column. They have no salesmen, no advertising agencies, no service clubs like the Rotary, no civic clubs or charities.

But despite everything, they have a zeal and devotion to their way of life that is impossible to convey.

EVERYDAY LIFE IS HARD

EVERYDAY LIFE for the city family is hard, but not unbearable. The biggest need is better housing; also, they have shoddy furniture, deplorable plumbing, and pay exorbitant prices for poor clothing. There are intriguing window displays of home appliances, but few available. State stores are the only places where things can be bought. The showpiece of the Soviet Union is GUM, the huge State department store that extends almost the full length of Red Square. It carries 30,000 items in 240 "shops" and is visited by 200,000 people each day. Inside, long lines of people seem unconcerned about the waiting. Most things are high-priced and of poor workmanship. It is all they have known, and find it difficult to imagine anything else. The only bargain was LP records—excellent recordings and all at one price of 10 rubles ($1) at the unofficial exchange rate; the store was always jammed.

Citizens who can afford it and get tickets see unsurpassed artistic performances of ballet, music, opera, dancing, and the like; all theaters are jam-packed. Food supply operates for the benefit of the industrial worker at the expense of the farmer. Relatively there is "cheap food" in the cities, compared to clothing, for example; but long queues at State stores bespeak inadequate transportation and refrigeration. Very few have cars. There seem to be four makes: Zis—most expensive, not for private sale, used by officials, big, luxurious, and made from 1941 dies purchased in the United States by the USSR; Zim—large Russian designed car somewhat like a 1949 Buick, costs about $5,000 for private sale; Pobeda—something like a 1949 Chevrolet, costs about $1,600 (20 months' pay for average worker); and the most popular private auto, Moskvich—small European car, about $1,000.

Most improvements for everyday living probably are bound up with the Soviet making available more iron and steel for civilian use, and an expanded textile industry. However, no one seemed to have any concern with voicing his views on such matters of Soviet policy. It was not fear; just lack of interest, and a willingness to accept whatever policies for allocation of material the leaders thought best.

The housing shortage is acute—probably more so than anywhere else in the world—especially in Moscow with a seven to eight million population. Approaching Moscow from the airport, one sees forests of towering construction cranes building houses like mad all over the city. No structural steel framing is used, only cement blocks; many are finished with brick veneer and contain

Fig. 2. Dnieper hydro-power station at Zaporozhye. Power plant consists of nine vertical Francis turbines and nine 90-mva, 83-rpm waterwheel generators. Average annual output: 3,060 million kw-hr.

Fig. 3. Some "emancipated" Russian women lugging mortar and cement to build Moscow's new television studios.

no large windows or airy apartments. Close up, construction appears poor and workmanship shoddy. Both men and women work on buildings. Emphasis is on quantity, not quality—this was apparent from obvious deterioration of many buildings in Moscow that were only a few years old. However, the vast Moscow University, built in four years, is definitely the exception; workmanship inside and out was excellent. Intermixed with the new apartments were hundreds of old wooden buildings, which presumably will be replaced soon.

Ordinary people seemed to thirst for knowledge and culture. The stores selling books always seemed crowded with poorly dressed peasant-looking citizens. As we toured some of the richest art and historical collections in the world, one could not help but be impressed by the crowds of unsophisticated Soviet citizens, and the serious interest displayed by boys and girls who were everywhere. Each day there were long lines of ordinary people waiting to see the historic relics at the Kremlin museums.

Religion is just for the "old folks." Concentration is placed on the young people, who almost wholly follow the militant state "religion." Estimates of those belonging to any religious faith ran from 1 to 5% of city population, and from 20 to 25% rural folks. Divorces are difficult to obtain and very expensive. If the wife is found to be at fault, she must pay alimony to her ex-husband.

People impressed me quite differently in the three cities we visited. In Moscow they seemed intense, and rather poorly dressed. In Leningrad, more relaxed, and better dressed. In the relatively small city of Zaporozhye in Ukraine, almost carefree, with smiles and laughter here and there; and family groups strolling about in streets, fairly well dressed. At receptions, the officials and high-ranking Soviet guests were well dressed in conservative styles; I observed no drunkenness, begging, or rowdyism at any IEC affairs, or on the streets during the entire visit. People were curious about us; I was stopped on the street three times by students who spoke excellent English and was usually questioned at social affairs. They get no news of the "outside," and the Voice of America is pretty well jammed. A few Soviet citizens evidently get some United States stations direct via short wave.

EDUCATION IS PROMISING FORCE

SOVIET UNIVERSITIES probably are the most promising force for the future in changing the USSR. For example, students we met at the Moscow University were alert, eager, and intelligent. The massive educational program sponsored by the Soviet for essential industrialization and teaching Marxism may be the very force that will weaken communism. Since the Revolution of 1917, a whole nation has been taught to read, and an ever-increasing number taught to think. By its nature, people trained in scientific processes eventually may find themselves incompatible with any dogmatism, including Marxism. I was told the USSR graduated 132,000 "engineers and scientific workers" last year, but was unable to confirm the figure or get breakdown of categories. (EDITOR'S NOTE: According to a Moscow news release, the Soviet Union boasted that in the 1956-57 school year, Soviet institutions graduated 265,000 technical specialists, of which 80,000 were engineers. This means that the USSR holds a two-to-one advantage in engineering students. The present annual total of American engineering graduates is 32,000.)

The Soviet education system is impressive. Starting

Fig. 4. Spectacular fountain display at the Agricultural and Industrial Exhibition in Moscow, a permanent World's Fair type of exhibit.

last Fall, *universal* compulsory 10-year secondary education was introduced; and expected to be achieved by 1960. Students start at 7 years of age. Subjects on the 10-year school schedule include: Russian language and literature, foreign language, Constitution USSR, history, geography, psychology, arithmetic, algebra, geometry, trigonometry, chemistry, physics, astronomy, drawing, manual arts, physical culture, and sports, and some military training. A foreign language is taught for 6 years. I was told that about half of the class hours in the last three years are mathematics and sciences.

For higher university training, the process is selective and based on examination. Practically all students receive scholarships based on grades; e.g., 96% at Moscow University. Moscow University is the oldest (1755), has 210 departments, 12 different faculties totaling over 2,000 professors and teachers; 22,000 students in training for industry, agriculture, science and education. Engineers (electrical, mechanical, radio, etc.) are not trained at Moscow University, but at the Moscow Energetic Institute, with about 9,000 students.

AIM TO BE FIRST INDUSTRIALLY

THE ULTIMATE AIM of the USSR is to surpass the U.S.A. economically. However, as compared to the United States at present, they probably have only about 50% of United States production of steel; perhaps 70% Btu-content in coal and lignite; 20 to 25% of oil; maybe 30 to 40% electric energy; and about 50% agricultural production. Over-all industrial growth is estimated at 5 to 6% annually. The big shakeup this year that decentralized industry may be to bolster the sagging sixth 5-Year Plan (1956-60) which was cut back from 10% to 7% increase for this year. Of course, one serious flaw is that there is no competition, since much of the system is still highly bureaucratized. Payoff is for overfulfilling the "norms" that are established for every job. Result is quantity of a sort, without quality. Traditionally, as far as I could learn the mass of Soviet people have been workers and followers—not planners, which so far probably has simplified the administrative industrialization problem for the Soviet leaders.

During our visit, the USSR seemed willing to show us practically anything we wanted to see. Everywhere we went we found the Soviets: (1) proud of what they have done; (2) pressing ahead aggressively on projects which somehow seem to work even if they do not meet our ideas of efficiency or craftsmanship; (3) always planning for bigger and better things ahead; (4) presenting best possible "front"; (5) possessing a degree of patience that is incomprehensible; and (6) carefully and systematically "cultivating" the young people.

Perhaps some hopeful signs for the future include: (1) relaxing of tourist restrictions; (2) active exchange of scientific, cultural, economic delegations; (3) Soviet "visitors" being sent to other countries (one Russian estimated 20,000 a year, but very few to the United States because the United States requires fingerprinting) (recently changed); (4) aggressive solicitation of international technical meeting like IEC or International Automatic Control Society; (5) increasing economic decentralization;(6) seemingly less maximum security precautions for Soviet leaders in public; e.g., at the U.S. Embassy reception we attended, only a few two-car groups appeared to be used; and (7) perhaps most significant of all their impressive educational system.

Theoretically, of course, everyone is equal—but as we soon observed, some are "more equal" and enjoy the better things of life. Recent economic decentralization appearing in industry and agriculture probably will tend to increase the stratification of Soviet society. And as a result, it is possible that as those in the higher classes increase they may be more inclined towards theoretical and perfunctory acceptance of the doctrine, simply to protect their way of living.

TREMENDOUS INDUSTRIAL POTENTIAL

DESPITE MANY SHORTCOMINGS, my impression is that the Soviets are "leading from strength." They have the raw resources, manpower, thirst for knowledge, a gigantic educational program, and a will to achieve scientific and engineering pre-eminence that will probably bring increasing results. Technically, I have a feeling they can do whatever they put their mind to. The result may not be as bright and shiny as we would like, but it works, and works well.

If they succeed in developing effective "organization and management" as we know them, I believe the USSR could easily "explode industrially" within a decade or two.

Soviet universities may well be the most promising force for the future. By the very nature of education, you cannot train people's minds in scientific processes and at the same time control what they are going to think.

Thus, the massive educational program, sponsored by the Soviet Union for speeding industralization, may be the very force that will finally short-circuit much of communism.

Missile Battery

Silver-zinc batteries, already widely used in most missiles and rockets, are the only type of batteries used in the BOMARC *IM-99* long-range missile. Yardney Silvercel batteries, a product of the Yardney Electric Corp., serve as basic sources of energy for control and guidance, providing power for the hydraulic controls which steer the missile, the guidance electronic equipment ("intelligence" section), and the telemetering instruments.

They make use of a silver-zinc couple which is up to five times more powerful than elements used in other batteries. This power ratio enables them to be as small as one fifth the size and one sixth the weight of batteries of comparable ampere-hour capacity.

Earth Satellite Telemetry Coding System

R. W. ROCHELLE

The different bandwidth requirements for the various inputs from the transducers in the earth satellite led to a system which is a combination of time-sharing and frequency-sharing telemetry. To illustrate, a simple three-channel system is first described. This is then extended to cover the 48-channel system.

THE FUNCTION of the telemetry encoder for the earth satellite is to receive the signal inputs from the various types of transducers and to proportion them in time or frequency for modulation of the Minitrack transmitter. The bandwidths of the signals from the transducers range from essentially d-c to 100 cps; the latter bandwidth being neccessary to determine accurately the instantaneous position of the satellite with respect to the sun.

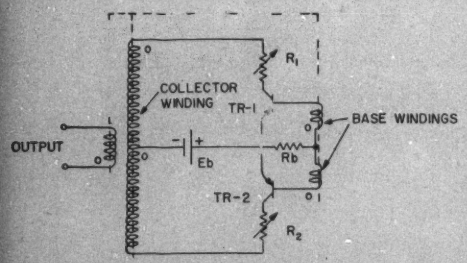

Fig. 1. Square wave magnetically coupled multivibrator.

The encoder itself operates on a time-sharing principle and provides gates which operate audio-frequency multivibrators. The length of time that these multivibrators are on, the frequency of oscillation, and the length of time between oscillation periods provides three channels of information. The inputs to the encoder may be either voltage, current, or resistive sources.

PRINCIPLE OF OPERATION

THE SIMPLEST SYSTEM would be one with a three-channel capacity, two of the channels being a time or pulse length measurement and the third a frequency measurement. The generation of the pulse length and the frequency is conveniently done by means of square hysteresis-loop magnetic materials.

A toroidal magnetic core is used in a magnetically-coupled multivibrator as a time reference for determining the pulse lengths. Another multivibrator using a magnetic core and operating at a much higher frequency establishes the frequency measurement. Fig. 1 shows the connection of a square wave magnetically coupled multivibrator[1,2] used as a timing device. Resistive transducers R_1 and R_2 are in series with each of the collector leads of the transistors. With R_1 and R_2 assumed to be zero, the output winding voltages would be a square wave. In operation, if transistor *TR-1* is held on by the base winding voltage from the core, then *TR-2* is held off, and magnetizing current flows through the collector winding of *TR-1*. The voltage across the collector winding is equal to the battery voltage less the small drop across the transistor. The current will remain approximately constant until saturation flux density occurs in the core. At saturation, the voltage across the base winding collapses turning off transistor *TR-1*, and transistor *TR-2* will be turned on by the kickback voltage of the core. Transistor *TR-2* is now energized by its base winding, and magnetizing current flows in it until saturation in the opposite direction is reached. The time in going from one knee of the hysteresis loop to the other is the period of the positive half cycle and is uniquely determined by the maximum flux in the core, number of turns in the collector winding, and the voltage across the winding. Since the maximum flux is proportional to the time integral of the voltage across the core, halving battery voltage will double the half-cycle period. If the transducer resistance, R_1, is not zero, magnetizing current will cause a voltage drop across it, and the core voltage will be reduced. The half-cycle period will then be lengthened. By varying the resistance of R_1, the positive half-cycle period will vary. If R_2 is varied, the negative half-cycle period will change. It is now possible to control independently the length of the positive half cycle with R_1 and the negative half cycle with R_2, making an asymmetrical square wave.

Consider now another magnetically coupled multivibrator or oscillator with a frequency of at least twenty times that of the timing multivibrator. Instead of separate transducers in each collector lead, only one is placed in the battery lead. This will perform the same function as the other transducers except that the period of both half cycles will be lengthened equally by it. This transducer controls the frequency of the multivibrator output. If now the positive half cycle of the low frequency or timing core is used as a gate to turn on the

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The author wishes to thank J. H. Perry for his excellent reduction of the satellite encoder onto a printed wiring card and P. E. Burris for his skill and patience in winding the many experimental toroids.

higher frequency multivibrator, a three-channel system results. The timing multivibrator output winding may be used in this application by driving the center-tap of the high-frequency multivibrator base winding, as in Fig. 2. Since the amplitude is a function of the transducer resistance, it is usually desirable to clip the output. Bottom drawing of Fig. 2 shows the clipped output of a three-channel system.

To increase the channel capacity to six, two more transistors and transducers are added to the timing core, as in Fig. 3. The center-taps of the base windings, *A* and *B*, are gated on and off in the same manner as the high-frequency multivibrator base windings were gated on and off. If the base windings of transistor *TR-1* and *TR-2* are gated on by means of a pulse at *A*, transducers R_1 and R_2 will control the length of the positive and negative half cycles. If at the completion of the negative half cycle the gate is switched from A to B, then R_4 and R_5 will control the duration of the next positive and negative half cycles. The gate is then switched back to *A* and the process repeated. The output wave from the timing multivibrator now contains four variable half cycles, the time of each is proportional to a transducer resistance. Automatic switching from *A* to *B* is provided by a binary counter or flip-flop triggered on each positive half cycle. Gates *A* and *B* may be used to switch between two transducers in the battery lead of the high-frequency multivibrator. Fig. 4 is a schematic of the complete six-channel system. The output signal contains two frequency measurements and four time measurements.

The extension to a 12-channel system necessitates the addition of another binary counter triggered from the first binary stage. The states of the binary stages are sampled by the bases of a matrix of n-p-n transistors, as in Fig. 5. When the left-hand transistors of each binary stage are on, gate *A* is energized. As the first binary stage is triggered, gate *B* is energized. At the end of the cycle the second stage flips and the first binary stage flips back to its original state, energizing gate *C*. At the end of that cycle only the first stage flips, energizing gate *D*. Gates *A*, *B*, *C*, and *D* are applied to four center-tap base windings on the timing core, and also they are used to switch in resistive transducers into the high-frequency multivibrator providing four frequency channels and eight time channels.

For larger systems, a binary stage is added for each doubling of the number of channels, and the number of transistors in the matrix is also increased. Fig. 6 is a drawing of a section of the output waveform showing that information is obtained from the frequency, lengths of tone bursts, and times between tone bursts. For the satellite installation, it is necessary to use a 48-channel system with four binary stages; however, there are only 17 separate channels because of the repeating of channels which need a larger share of the frame time. This reduces the complexity of the matrix; instead of 16 gates being required, only 6 are needed.

It was previously mentioned that the gates were used to turn on the transducers in the battery lead of the

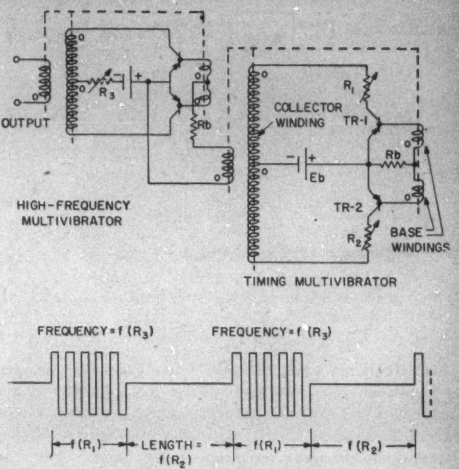


Fig. 2. Three-channel telemetry system.

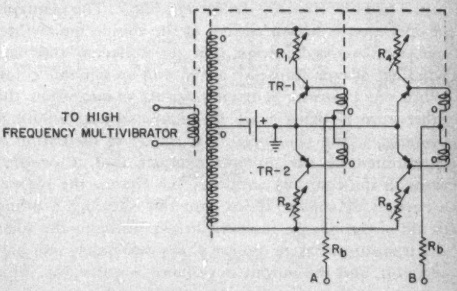


Fig. 3. Six-channel timing multivibrator.

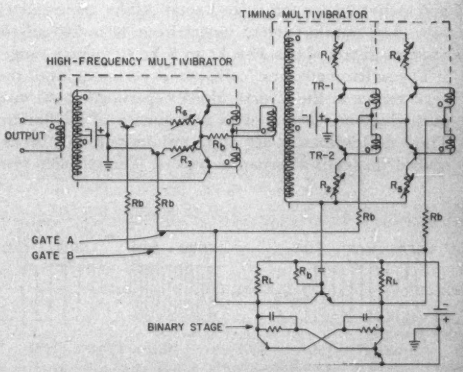


Fig. 4. Complete six-channel telemetry system.

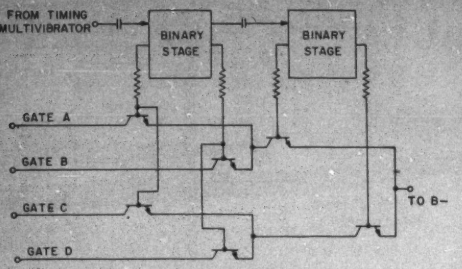


Fig. 5. Transistor matrix.

high-frequency multivibrator. These gates may be used in another way. They may energize the base windings of separate high-frequency multivibrators—the output of these being in series. Instead of controlling the frequency by changing resistance in the battery lead, the frequency may be changed by several means dictated by transducer characteristics. R. L. Van Allen has developed a variable-frequency magnetic-coupled multivibrator[3] which takes either a current or a voltage as its input. The basic circuit is detailed in Fig. 7. The principle of operation is similar to that of the timing multivibrator just described, except that the collector and base windings of each transistor are wound on separate cores. While one transistor is driving its core to saturation, the other core is being reset through coupling windings common to the two cores. The period of oscillation is determined by the amount of reset that is coupled through the coupling windings. To change the period, a current or voltage is fed into the coupling winding to aid or oppose the reset. In bright sunlight, the solar cell transducer has an output of approximately one half of a volt, and the output impedance is quite low. This voltage feeding directly into the coupling windings shifts the frequency of the multivibrator from 12.5 kc down to 5 kc. By changing the number of turns in the coupling winding, the circuit can accommodate the current delivered by the solar Lyman alpha electrometer tube. The output current ranges from 30 to 700 microamperes giving also a 12.5 kc to 5 kc frequency range.

The micrometeoritic collision experiment and the peak reader of the Lyman alpha experiment have outputs which are measured as a frequency of oscillation. These multivibrators are quite unique and will be described in detail in separate papers. The encoder provides gates which sequentially switch each of these multivibrators on at the proper time, similar to the way that the magnetically coupled multivibrator was switched on. These multivibrators do not have base windings; consequently, a transistor operated by the gate is used to switch them on and off.

The output winding of each of the high-frequency multivibrators are connected in series and applied as a push–pull signal to a combination clipper and modulator stage. The connections are given in Fig. 8. The transistors are driven to saturation so that the percentage of modulation of the Minitrack transmitter is constant. The modulation transformer core is a square hysteresis loop material with low magnetizing current requirements.

Because of the severe weight restrictions in instrumentation in the satellite, calculations were made to determine the minimum weight for maximum volt-second core capacity.[4] Since the unit is required to operate for at least two weeks, it is desirable to minimize current rather than core weight. The combined battery weight and timing-core weight is lighter for the materials with low magnetizing currents than with materials of high flux density. This results in a heavier timing core but lighter over-all weight. The weight of the timing core with windings is two thirds of an ounce. The combined weight of the encoder, modulator, and two of the high-frequency multivibrators is 3.2 ounces. The encoder itself draws two milliamperes of current at 2.6 volts. Another two milliamperes are used by the high-frequency multivibrators, giving a total drain of four milliamperes. Fig. 9 shows the top view of the encoder. Printed wiring techniques greatly simplify the construction of the units.

A conventional transistorized binary stage uses two transistors with load resistances in the collectors and

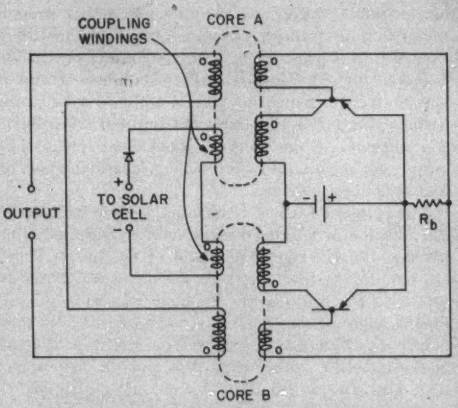


Fig. 7. Variable-frequency, magnetically coupled multivibrator.

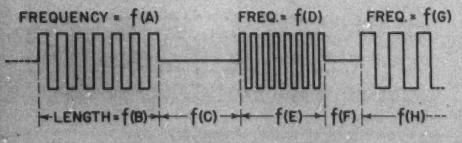


Fig. 6. Output waveform drawing.

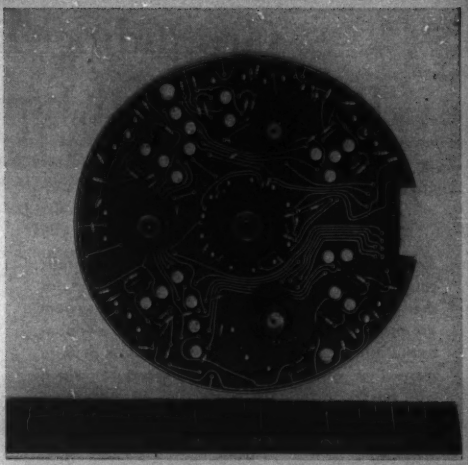
two diodes in the steering circuit, as shown in Fig. 10a. If the load resistance is low, battery drain is excessive, and if the resistance is high, it is difficult to trigger under load reliably. To alleviate this situation, two transistors replace the load resistors in a symmetrical arrangement. Complementary p-n-p and n-p-n transistors[5,6] are used in each leg of the binary in a manner similar to that reported by R. H. Baker. This provides a variable load impedance which reduces the battery drain and improves the reliability. A convenient means of triggering the binary stage is to connect a transistor between the collectors and drive its base with the trigger pulses. The steering transistor should have a good reverse-alpha characteristic since one half of the time it is used in the reverse-alpha connection. The battery drain is 200 microamperes per binary stage at 2.6 volts.

ACCURACY AND RESOLUTION

As used in the satellite, the range of variation of the transducers in the collector leads of the timing multivibrator may be from zero to 5,000 ohms. A thermistor or pressure transducer fits this range rather nicely. For this range, a timing pulse would lengthen from 5 milliseconds to around 30 milliseconds. Since magnetizing current increases as saturation is approached, it is desirable to load the timing core with a resistance to linearize the plot of time vs. pulse length.

The absolute accuracy of the system depends upon the signal-to-noise ratio of the received signal. Extremes in temperature change the magnetizing current and the maximum flux density in the cores a few percent and must be included in the calibration for high accuracy. Transistor temperature effects are noticeable only when leakage currents become excessive. Since in these applications the transistors are being used only as switches and in a saturated condition, variation of parameters has little effect.

The time of observation of the satellite from the ground is limited by the effective receiving antenna beam width. It is desirable to encode into the transmitted signal as much information as possible. In conventional pulse-width or pulse-position systems, a finite time is set aside for each channel resulting in wasted time if the dynamic range of that channel is not used. In the satellite encoder, the channel widths are functions of the signals so that more information is sent if the dynamic range of a channel is not used. There is little dead time in the transmitted signal except for the minimum pulse length. Although more information is being received at the ground station, a signal of this type is more difficult to decode. Complexity in the data read-out equipment in this case is a small price to pay for the reduction of size and weight of the satellite instrumentation.



Official Photographs, U.S. Navy

Fig. 9. Top view of encoder.

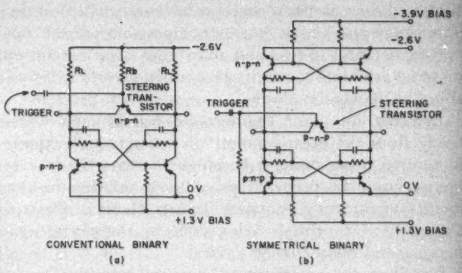


Fig. 10. Binary stage.

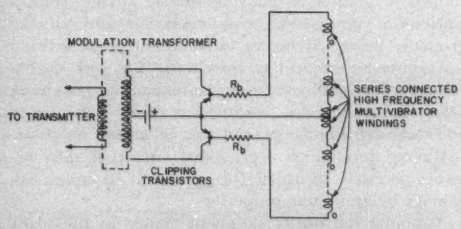


Fig. 8. Clipper and modulator stage.

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Grounding Techniques for Personnel and Equipment Protection

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ASSOCIATE MEMBER AIEE

As an example of how information from various sources can be assembled into useful form for the operating engineer, a guide on system grounding techniques is presented. In addition to the initial establishment of grounds, a definite inspection and maintenance procedure which will assure adequate protection of personnel and equipment is recommended.

THE POSITION OF PLANT ENGINEER requires a working knowledge of many of the branches of engineering. Advancements in techniques, theory, and new concepts have snowballed in the past few years, and it becomes impossible for the operating engineer to read and absorb the large amount of material available concerning his functions and still continue his day-to-day duties.

In order for plant engineers to benefit most effectively from the great amount of research and experimentation being done, it becomes necessary that a reference guide be prepared on subjects relating to the facility engineering function. In the General Electric Company (GE), this is being done by the plant engineering and maintenance service.

Standards are not prepared, because individual components of the company have distinct problems and procedures that do not lend themselves to one set of rules. Instead, guides are prepared with which each operating component may establish its own standards by utilizing the portions applicable to its operation without the necessity of hours of research to find and assemble the most up-to-date techniques and developments available. These guides must be kept up to date and consistent with the latest and most applicable research.

An example of this "integration of knowledge" into a usable form for the operating engineer will be given here. The general topic is "grounding techniques."

SYSTEM GROUNDING

AT SOME TIME OR ANOTHER, the decision must be made as to whether the electric distribution system in a plant should be operated intentionally grounded or unintentionally grounded. It is GE's recommendation that in all cases for 3-phase installation in our plants, the grounded-Y system be used. A summary of the advantages and disadvantages of both systems will reveal the reason for this recommendation.

First, the grounded system is safer for both equipment and personnel. The voltage-to-ground on a grounded system is limited to approximately 58% of phase voltage at all times. However, when a ground-fault condition exists on one phase of an ungrounded system, the other two phases have full phase voltage to ground; or even several times phase voltage to ground, if the fault is of repetitive restrike type. This condition obviously could cause considerable damage to other electric equipment in the circuit.

Second, the maintenance cost and time is considerably less when a ground fault on a grounded system is repaired, because this type of fault is very simple to locate and does not require that large portions of the circuit be shut down while the "pull the switch" method is being used to track down a ground or grounds on the ungrounded system. Ground-locating equipment can be utilized and, with a well-trained operator, the ground approximately located. This involves additional equipment, and brings us to the third point of comparison—cost.

For all practical purposes, on a new installation, the first cost is a standoff. The neutral relaying and ground resistor necessary in the grounded system is equalized costwise by the ground-detecting and ground-locating equipment necessary for operation of the ungrounded system.

Fourth, in the case of a 480-volt Y grounded distribution system, the 277-volt line-to-neutral circuits are used directly for fluorescent lighting. Extra cost of step-down lighting transformers is eliminated, and copper costs and losses are less, because of the higher voltage lighting circuit.

The fifth and last item of comparison for certain conditions is in favor of the ungrounded circuit. With a continuous or "batch" type operation and an ungrounded power system, a ground on one phase will not necessitate an immediate shutdown. The risk that a second ground will not develop in one of the remaining phases before there is time to shut down conveniently and clear the original ground may be taken.

Having decided on a grounded circuit, it then becomes necessary to utilize this system to its fullest advantage by grounding properly.

Assuming the utility supplying power to the plant has properly grounded the main substation, the prob-

Essentially full text of paper 57-920, "A Compendium of Grounding Techniques for Personnel and Equipment Protection," recommended by the AIEE Protective Devices Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, Pasco, Wash., Aug. 28-30, 1957.

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lem facing the plant engineer is to provide adequate building and equipment grounding.

ESTABLISHING GROUNDS

ALL STEEL FRAMES of buildings must be adequately grounded. As a minimum, a ground bus of not less than no. 4/0 AWG copper should be run around the periphery of the building, connected to each outside building column, and connected to earth at intervals of not more than 200 feet.

Each water main entering the building, if suitable for use as a ground, should be connected to the ground bus at two or more points. In large buildings, the ground bus should be extended to connect to an adequate number of internal building columns.

The connection to earth mentioned previously is accomplished by the use of driven ground rods supplemented by an underground water piping system, if available. Ground rods should be of copper-clad steel not less than 3/4-inch diameter and 10-feet long. It is desirable that the ground resistance be less than 5 ohms. Enough ground rods should be driven to satisfy this condition.

In locations where the driven-rod method is inadequate because of soil conditions or high bed rock, grounds should be made by a suitable subsurface network. In abnormally poor soil conditions or for extremely low ground resistance requirements, the soil resistivity immediately surrounding the driven ground or network can be reduced appreciably by treating with sodium chloride or calcium chloride solution. If this is necessary, the treatment probably will have to be repeated every year or two to maintain sufficiently low "to earth" resistance.

All buried ground connections should be made by brazing or the Cadweld process. All other ground connections should be made by brazing, welding, or with approved pressure-type terminals, properly applied.

Quite frequently, corrosion of underground steel or the lead of underground lead-jacketed cable will occur as the result of an electrochemical reaction. This is caused by dissimilar metals, dissimilar soil resistivity, and stray currents.

This condition exists in varying degrees in most plants. Preventive or corrective measures may be used, such as applying a nonconductive protective coating to underground steel- and lead-covered cables, providing sacrificial anodes of zinc or aluminum in the vicinity of the underground steel and copper ground network, or providing a rectifier-fed ground bed system. Inasmuch as there are many variables, every corrosion problem of this type associated with grounding is a distinct problem, and no cure-all solution should be attempted. A complete study of the specific problem is required.[1]

EQUIPMENT GROUNDING

IN ORDER TO ACHIEVE maximum safety from shock hazard for all personnel, it is necessary that all metallic structures, junction boxes, machine frames, motor frames, enclosures, portable equipment—in fact, any item capable of carrying an electric current and enclosing, or in close proximity to, an electric circuit—be at ground potential at all times.

A low impedance path must be intentionally provided. If this is not done, the item probably becomes isolated from ground and is connected to earth through a semiconductor of several thousand ohms or many megohms, if totally insulated.

There are, therefore, three general categories concerning the adequacy of the grounding of equipment, each giving different results in the event of an accidental contact between the electric circuit and the enclosing body, machine frame, etc.

The first is the condition of extremely high resistance isolation from ground. Here, the structure assumes the potential of the circuit with which it has come in contact and becomes a lethal hazard to personnel.

The second is the condition of several thousand ohms resistance to ground through some semiconducting path. Here, the structure again assumes the potential of the circuit with which it has come in contact and once again is a personnel hazard. In addition to this, the moderate resistance path or leakage path to ground could allow enough current flow to cause heating and the ignition of any combustible material present. (This is not an uncommon occurrence.)

The third is the condition of proper ground connections with but a minimum resistance and adequate ground conductor size to carry the ground fault current for a short time. Here, the structure potential would not rise high enough above ground to be dangerous to personnel, and the current flow through a guided path to earth would not be the cause of fires. Furthermore, the ground-current flow is of such a high magnitude that instantaneous short-circuit relays or ground-fault relays are actuated, and the electric circuit at fault is de-energized by its circuit breaker (or fuse) in but very few cycles.

It is this third condition we want to attain on all exposed items capable of conducting an electric current. The following equipment grounding practices are recommended:

1. The grounding conductor should in no case be a system neutral or a current-carrying conductor.

2. The enclosing cases, mounting frames, etc., of all switches, circuit breakers, control panels, motors, and other electric or electrically operated equipment must be grounded by running a grounding conductor from a ground established at the source of supply to the equipment to be grounded.

3. The grounding conductor should be run inside the conduit or wiring channel enclosing the power conductors supplying the equipment, or in the case of a multiconductor cable, should be located inside the sheath of the cable. The only exception to this is in the case of a lead-sheathed power cable where the lead sheath may, in most cases, be used as the grounding conductor and must be connected to ground at each

end. Results of recent tests conducted at the GE Schenectady (N.Y.) plant lead to the conclusion that when the circuit conductors are enclosed in conduit, armor, etc., and the ground return remote, the metallic enclosure will carry the major portion of the fault current. This causes arcing and possible fires at breaks, and loose or deteriorated enclosure joints and terminations. Voltage to ground of the enclosure can, under these conditions, reach hazardous levels. This effect is caused by the inductive reactance of a ground return remote from the outgoing conductor being high as compared to its resistance. Thus, the amount of return current it will carry is definitely limited. The farther the ground return is from the supply conductor, the higher its inductive reactance. Therefore, if additional capacity is required in the ground return circuit, it should be added inside the enclosure.[2]

4. All metallic conduits, wiring channels, and the armor of armored or BX cables must be connected at each end to the grounding conductor or firmly attached at each with a good electrical contact to a properly grounded connection box. All ground connections must be connected to the grounding conductor which must be run through the connection box.

5. Where circuits consist of two or more power conductors in a conduit or wiring channel, the grounding conductor may be one standard wire size smaller than the power conductor, but in no case smaller than no. 14 AWG or larger than no. 4/0 AWG. The grounding conductor shall be stranded and covered with green flamenol (type TW) jacket up to no. 2 AWG. Larger sizes may be bare stranded. If green is not available, the grounding conductor should be clearly and permanently identified at all terminating points or taps by use of green adhesive marking tape code markers, or other similar identifying means.

6. In multiconductor cables, the green conductor is to be used as the grounding conductor and the white conductor as the system neutral.

7. In varnished cambric interlocked armor, use the two or three grounding conductors in the interstices between the larger current-carrying power and neutral conductors. Because of corrosive action causing increased resistance with age, the sheath of the interlocked armor does not make a satisfactory ground. The combined sizes of the grounding conductors furnished with this type of interlocked armor cable equals about 50% of the size of one power conductor.

8. In BX or Romex cable, if no green conductor is furnished, the red should be used as the grounding conductor. It is not recommended that the small grounding wire furnished with smaller (14 AWG and 12 AWG) sizes of BX cable be used for industrial installations as the grounding conductor.

9. In addition to the foregoing, if a machine frame, switchgear enclosure, control panel, etc., is located within 6 feet of a metallic ground, such as building steel, metal pipes, or other machine frames and is not interconnected mechanically by structural steel, pipes, conduits, or the like, the circuit length of which is less than 100 feet, a bare copper conductor of a size previously discussed should be used to interconnect these items directly.

10. Lighting fixtures, whether incandescent, mercury, or fluorescent, should be grounded in accordance with the practices just outlined for equipment. A continuous row of fixtures may be considered as one fixture, if the mechanical connections between fixtures are such that electrical continuity is assured. If additional information is desired, refer to Article 410, Sections 4211-4216, inclusive, of the National Electrical Code (NEC).

GROUNDING PORTABLE EQUIPMENT (BELOW 600 VOLTS)

THE NATIONAL ELECTRICAL CODE for several years has banned the use of flexible cords with the "pigtail" type of grounding connections at the plug under any of the following conditions: (1) hazardous locations (as defined in the NEC in Articles 500 and 510); or (2) if operated at more than 150 volts to ground (with minor exceptions); or (3) in other than residential occupancies where the user may be in a damp or wet location, or standing on the ground or on metal floors, or working inside metal tanks or boilers.

Section 2559 of the NEC details the three ways this grounding may properly be accomplished:

1. By means of the metal enclosure of the conductors supplying power to the portable equipment, provided an approved plug is used with one pin for connecting the metal enclosure to ground; or

2. By means of a separate grounding conductor in the flexible cord supplying power, provided the approved grounding pin type of plug is used, which must make proper contact with the grounding conductor installed in the raceway; or

3. A separate wire or strap may be used only by "special permission" except where a part of an approved portable equipment.

The aforementioned rules cover most all usage of portable electric equipment, and in the best interest of personnel safety, must be followed.

Therefore, all portable electric equipment used in GE factories and offices should be provided with a 3-wire cord, two for power supply and one with green jacket (as specified by NEC) for the ground. All 120-volt or 240-volt receptacles should be of the type specified by the American Standards Association (ASA) and National Electrical Manufacturers Association (NEMA), and required by NEC. The 120-volt receptacle receives parallel blade plugs, and the 240-volt receptacle receives tandem blades. Both receptacles receive the third stab of circular design, which is the ground connection. This grounding should be securely fastened to the grounding circuit, never the power circuit neutral.

The approved matching plugs to be used are available in several types for both voltages. The several types allow for proper termination of the various kinds of multiconductor cable jackets.

It is essential that a qualified electrician do the original installation, as well as all repair work on these flexible cords, because a well-meaning "tinkerer" could easily fasten the ground wire to one of the power blades of the plug or connect the wrong wire to the frame of the machine or hand tool when replacing or repairing a cord. This, of course, would create a most hazardous condition.

It is not generally recommended that 480-volt circuits be plugged, in view of the higher normal and short circuit currents available. However, if it is found that a piece of 480-volt equipment, such as a maintenance arc welder, is continually being used in various locations of the plant, 480-volt receptacles may, for convenience and time saving, be provided. The same rules for grounding apply as for the lower-voltage circuits. The receptacle and plug used must be of proper capacity and voltage rating, and approved equipment of this type is made by several manufacturers. The receptacle should be immediately preceded by a safety disconnect switch interlocked with the receptacle.

The operating procedure is always to open the disconnect before plugging or unplugging the power lead. Various types of switch–receptacle interlocks have been developed and used to assure that the circuit is de-energized before plugging or unplugging.

PORTABLE EQUIPMENT ABOVE 600 VOLTS

PORTABLE EQUIPMENT operating at supply voltages above 600 volts should not be plugged, and must have the flexible lead permanently connected to a fixed termination at both ends. The same grounding practices apply as for lower-voltage supplies. The grounding conductor shall be one of the multiconductors in the flexible lead and properly terminated at each end.

In all cases, regardless of voltage, grounding of portable equipment can create a hazard instead of safety if it is initially not installed properly and then given frequent periodic checks for correct connections and tight, good conducting terminations.

STATIC ELECTRICITY

STATIC ELECTRICITY discharge arcs cause a considerable number of explosions and "after fires" every year, resulting in loss of life and heavy property damage. The application of the best known building and equipment grounding techniques is not always an adequate solution. Each installation in a hazardous location should be studied separately to determine the necessity and means of safely removing static charges.

Static electricity is produced by the action of contact and separation of dissimilar substances, one of which is an insulator, such as a rapidly moving belt and pulley.

Contact of these substances causes readjustment of their molecular structure which, in turn, causes the flow of electrons at each molecular contact point. The material to which the electrons pass becomes negatively charged and, of course, the material losing electrons becomes positively charged. This causes a potential difference between the two substances. The greater the speed of separation of the two now oppositely charged substances, the greater the charge retention. Therefore, the potential difference between them is increased.

All other conditions being the same, the greater the difference between the two dielectric constants of the substances in contact, the greater the charge. The substance with the lower dielectric constant becomes negatively charged. Some of the other conditions affecting amount of charge are surface smoothness, area of contact, temperature, humidity, and the amount of motion between the two bodies.

The production of static electricity is not limited to dissimilar solids. Nonconducting liquids flowing through a pipe or agitated in a container will cause high static charges, and gas escaping at high velocity from a nozzle will also be the cause of static charges.

Some of the more frequently encountered hazardous areas are

1. Paint storage, mixing, or application areas
2. Electrolytic gas plants producing hydrogen and oxygen
3. Acetylene-generating plants
4. Propane storage and unloading stations
5. Plant hospitals
6. Volatile-liquid storage and use areas
7. Areas involving certain chemical-processing operations
8. Areas where dust dispersion is prevalent

These and any other areas which have the lethal combination of volatile vapors, gases, or dust, and the possibility of electrification from static charges should be studied and treated as individual cases. There is no one cure-all for electrostatic charges. The best preventive measures are to ground properly all equipment, structures, containers, and metallic items in the area, then provide a means of removing the charge as it is produced. This can be accomplished by the use of conducting belts or belt dressing on all belt drives, grounded conducting floors, conducting shoes, and possibly nonstatic producing clothing for employees in the area. In some cases, controlled humidification will assist in reducing the build-up of a high potential charge.

It is important enough to repeat that there is no one remedy for all cases. For example, some cures, such as humidification, will work extremely well for certain materials which are hygroscopic and have a high moisture-regain rate, while on other materials, humidification has little or no effect. Each condition is a problem in itself and should be treated as such.

In addition to being a source of ignition of combustible materials in hazardous areas, static electricity effects must also be considered in nonhazardous areas. An unexpected, slight static shock from an employee's hand can cause uncontrollable reflexes and possible injury in striking a sharp projection or becoming entangled in rotating machinery. Paper used in winding capacitors or on a continuous blueprint machine can be damaged by a static electricity discharge. Motor–generator set

bearings can be pitted and ruined by static discharges from the rotor to the grounded bearing pedestal. Assembly of small parts, such as found in radio receiver tubes, can become extremely difficult if the assembler is naturally dry-skinned or wears gloves which pick up a charge. There are many places in every plant and office where static electricity is either an annoyance or where it is a definite hazard to personnel, equipment, and product.

In nonhazardous areas, the charge may be removed by properly installing devices, such as grounded wires used as a brush on a motor–generator set shaft, or commercially available electrostatic grounding "combs," or a grounding "tinsel bar." Once again, each case requires individual study before taking preventive measures.

The most convenient method to test for an electrostatic charge is by use of a neon-tube type electric circuit or spark plug tester. The leads of the tester are held at the point where the static accumulation is suspected and, if present, a glow or flash will occur in the neon tube. Other detecting devices commercially available are the gold-leaf electroscope and the electrostatic voltmeter.

LIGHTNING PROTECTION

LIGHTNING is caused by the discharge of extremely high potential static electricity from a cloud of negative charge to a cloud of positive charge, or from a charged cloud to ground or vice versa. The lightning "stroke" is of short duration (a few microseconds) with very high current flow.

In discharging to ground, the lightning stroke, in most cases, follows "the path of least resistance." This could be a high steel tower, a building, a tree, etc. The purpose of lightning protection is to provide a controlled "path of least resistance" and eliminate injury to personnel or building and equipment damage from heat and mechanical forces caused by the passage of this extremely high current through a resistance, such as a building.

In addition to the damage caused by a direct stroke, high electrostatic voltages will be induced in any nearby metallic machine frame, tank, structure, etc., that is not properly grounded.

It is impossible to protect a building positively against damage from a lightning stroke unless the structure has a complete metal shell, properly grounded. However, a good installation of lightning rods will reduce the risk of damage considerably.

Because a lightning stroke will usually impinge upon the tallest conductive structure under a charged cloud, the lightning rod should be mounted on the highest point or series of points of the building. The lightning rod should have a sharp point which will cause a high electrostatic field density causing air ionization, and in effect, "attract" the lightning stroke by providing a path of less resistance.

The interconnecting leads from the rods to ground should be well connected to the rod and follow the shortest possible path to ground. The bare copper cable used should be 2/0 AWG or larger and, if at all possible, any sharp bends in the ground cable should be avoided. The connection to earth should be of very low resistance, 1 ohm or less, if at all possible. One or more 10-foot by ¾-inch copper-clad steel rods driven into the ground have been found to be adequate in most areas.

A high chimney, tower, or building with lightning protection on it will usually also afford protection for several lower buildings in the immediate area since experience has shown that a "cone of protection" normally exists whose base radius is equal to twice the height of the tallest structure.

In order to protect electric equipment from overvoltages caused by direct lightning strokes or induced by near misses on the incoming power lines, lightning arresters must be installed at the high side of the main substation transformers. Furthermore, if the secondary cables are overhead and run exposed for more than 100 feet before entering the plant, they also should have lightning arrester protection.

The action of the lightning arrester is to be that of an insulator for normal operating voltages, and a low impedance path to ground during an overvoltage, returning to the function of an insulator as soon as the overvoltage is relieved. It must be capable of interrupting the 60-cycle power "follow current" after the high-voltage condition has been removed. For grounding the arrester, as with the lightning rod, a minimum resistance-to-ground connection must be provided and maintained.

The voltage rating of the arrester to be used depends on the characteristics of the utility supply circuit to the plant. In no case shall the arrester voltage rating be less than the possible maximum line-to-ground operating voltage. This voltage rating is governed by the necessity of the arrester to seal off the follow current after its discharge to earth of the abnormal potential. The choice of arrester voltage should be co-ordinated with the engineering group of the local power company. These experts know the voltage regulation on their lines, system grounding conditions, possibilities of abnormal operating voltages, line-to-ground-fault voltage conditions, etc.

The best location for arresters is at the terminals of the equipment (usually a transformer) they are to protect. Inasmuch as this is not always possible physically, a small separation is allowable. However, it must be realized that part of the protection is being lost because of this separation.

As mentioned throughout this article, establishing good grounds and using proper techniques in installation can only provide the initial protection desired. A definite inspection and maintenance schedule must be established to assure that ground connections remain adequate, ground circuits are not broken or burned, resistance to earth is within prescribed limits, etc. In this way, the best known protection will be provided for personnel and equipment against shock, insulation failures, electrically ignited explosions, as well as fires

caused by circuit abnormalities and failures, static electricity, and lightning surges.

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The Remote Handling of Radiation Sources

J. W. WISSEL J. C. LEE

Engineering problems associated with the remote handling of radiation sources are discussed together with the human engineering involved in evaluating the demands the system makes on the operator.

THE MISSILE SYSTEMS DIVISION of the Lockheed Aircraft Corporation has recently completed the construction of a nuclear physics research building in the Stanford Industrial Park at Palo Alto, Calif. The nuclear physics department is concerned specifically with the "hot cell" and the remote handling of radiation sources. The exact nature of the studies that are currently being undertaken cannot be disclosed, but the operator problems are not unique.

At this point, we might briefly describe our equipment. We have a closed cell with a conventional remote viewing window—approximately 30 inches thick. Oil is interposed between the glass surfaces to minimize internal reflection. We have Argonne Model *8* remote master slave manipulators, which is associated with a closed-wall system—as opposed to the Argonne Model *7*, which is used with an open-ceiling configuration. In addition to the mechanical manipulators, we have a 1-ton remotely operated electric hoist that is used for tasks beyond the capacity of the manipulators. We also have a remote controlled closed-circuit television system which supplements the operator's direct version into the cell.

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HUMAN FACTORS IN DESIGN

THIS THEN is our physical equipment. Some people may wonder why human engineering people are concerned at all in this situation. Well, one thing that the nuclear operation has in common with all other systems is the fact that there are people in the system. While the electrical engineer focuses attention on the manipulation of the source and the progress of the experimentation, the human engineer is concerned with the demands that this particular endeavor makes on the operator. Are the demands of the system reasonable in view of the capabilities of the operator? In most cases, it is infinitely easier to change the equipment than to change the operator.

We are concerned primarily with designing complex weapons systems for use in fairly critical operating situations at Lockheed. When everything is operating normally, the demands are usually well within the limits of human capability. The major portion of effort is directed toward designing systems that men can operate, even under the most difficult conditions, when everything is going wrong. This makes the design task more complex and fundamentally establishes the requirement for a specialist in human behavior. We usually have a pretty good idea of how an individual functions in a normal situation, and this often leads to the statement by the design engineer that his equipment is simple to operate—just watch him demonstrate. We

know that in an emergency situation, when everything is going wrong, a man's ability to perceive and to act is sharply restricted. The exact nature and amount of degradation is not known however, because this information is rather difficult to get, but we can simulate certain emergency situations. This simulation, however, very often proves to be unrealistic. In a ground simulator, it is possible to create mechanical conditions associated with an aircraft engine failure, but the pilot is well aware of the fact that the "plane" is not going to crash. Even the simulation of an actual in-flight engine failure may not be sufficiently realistic to stress the individual to his physiological and psychological limits. We do not know very much about the behavior of a pilot escaping from a burning airplane, because it is difficult to place an observer in this situation and the pilot is usually too busy getting out to recall the details of how he did it. Fortunately, tape recorders and motion picture cameras are not subject to the same stresses as the human operator so we are gathering some data on emergency situations. Such data gathering is still pretty opportunistic, because we cannot systematically create true emergencies to suit our purposes.

RADIATION PROBLEMS

We find in the nuclear physics field, the situation is somewhat different. The radiation source always represents a potential threat in that excess exposure may produce irreversible physiological processes. In addition, further complications are introduced by virtue of the fact that the finesse of our perception and control is compromised by the mechanical devices we must use in order to provide protection for the operator. When the protective window in our "hot cell" was ordered, it was estimated that the filtering action of the glass brought about a 60% reduction in illumination. More recent estimates place this figure at 70% light loss, for which compensation can be made by increasing the illumination within the cell. The remote manipulation device is an ingenious mechanism, but it cannot duplicate the human hand, nor would such a duplication be practical, if possible.

If certain objects are grasped with the manipulators, it will be apparent that it is impossible to perform some operations with them because of the rigid grasping surfaces which do not conform to objects as well as human fingers. These same surfaces also make it difficult to grasp certain pieces of apparatus at extreme distances from their center of gravity. With direct mechanical linkage, there exists some kinesthetic feedback. While this is not necessarily in a one-to-one ratio, cues are present which enable the operator to perform rather delicate operations, such as squeezing a given number of drops from an eye dropper. The problems of feedback and design of controls represent fruitful areas where some of the data described in previous talks may be applied.

Even more critical in remote manipulation operations are the restrictions placed on the operator's vision. I have already mentioned the 70% light loss associated with the direct viewing window. The filtering action also tends to reduce contrast between objects making the visual task more difficult. The thickness of the glass tends to deceive the operator's sense of relative depth at extreme viewing angles. This distortion makes the manipulation task more difficult. Additionally, chromatic aberrations at these same extreme viewing angles tend to mask small details under white light. This problem can be corrected, however, by using monochromatic illumination. In a direct handling situation, the operator can grasp an object correctly with his eyes closed very soon after he has touched it with his hand. This is not true when using remote handling equipment. Therefore, the possibility of spilling a container in trying to pick it up is a matter for operator concern, and may place a limitation on certain types of manipulation.

The direct vision of the operator in our system has been supplemented through the use of a remote controlled, closed-link television system. At present, we have a single variable focus camera which can be slewed to the left or right and up or down. Because this is a black and white system, the operator does not have color cues and the two dimension presentation yields no depth cues. We have made preliminary investigations into the use of multiple television cameras producing two or more two dimensional displays and have speculated on the use of two cameras to yield a three dimensional or stereopticon display. While several of these approaches appear promising, we wish to maintain an integrated display and avoid the problem of several ambiguous displays.

REHEARSAL OF NEW PROCESSES

The conditions surrounding our remote handling make it essential that new processes be rehearsed. The operator practices the steps in the process many times before making a live run with the source. Despite the fact that we go through the required sequences many times and plan for all conceivable contingencies, unexpected situations are encountered. On one occasion, when the operator was working with the source and several items of apparatus on a table, the source was lost from sight. Either the source was pushed by another piece of apparatus or it rolled from the operator's field of vision. The operator then confidently turned from the viewing window to the television system which was brought into action. However, when he still could not locate the source even using the television system, things became somewhat more critical. In recounting the incident, the stress associated with the situation cannot be recreated. Almost anticlimactically, the operator finally located the source through the ingenious use of the remote manipulators to pick up a pocket mirror which made possible a close-in search of the area. A magnetic pick-up tool was then remotely modified to retrieve the source. It has been our policy to make all source containers magnetic whenever possible.

On another occasion, work was being conducted with a source which was embedded in a stainless steel cylinder, when the supporting metal wire broke off. Under

these circumstances, it was impossible to place the source in the shielded storage container. Even had it been possible to accomplish that task, it would have been impossible to have lifted the cylinder out again. The operator solved the problem by passing a wire through a loop on the metal casing and soldering it together. Inasmuch as this was a novel procedure which had not been rehearsed in advance, it presented a fairly difficult task.

One other experience to be mentioned points up the importance of human factors in this area. Dr. Lee was confronted with the problem of opening a sealed aluminum container of radioactive material. Presumably the standard methods of opening a metal container are available to engineers in this field. However, if shearing, sawing, or breaking are considered, one realizes immediately that some type of feedback and a considerable manipulator strength is required to insure a smooth positive physical action. The strength of our mechanical manipulators are only marginal for this operation, and furthermore, the backlash in the mechanical linkages detracts from the precision of manipulation. The operator solved this problem by designing an assembly which clamped the sample in a predetermined position and which electrically lowered a saw along guide rails. This materially reduced the burden of complexity, strength, and precision from the manipulator arms.

Just a few of the problems that have been encountered in our modest establishment at Lockheed have been mentioned. No doubt many nuclear engineers today have encountered similar situations and perhaps more complicated problems. Some of the things that have been covered may have already been eliminated because of advances in equipment design. It is obvious however, that there is room for improvement. We can improve our present equipment through a "retrofit" program. Operating experience provides the opportunity to re-evaluate operational requirements and to make modifications accordingly. I am sure that I need not tell you of the difficulty of changing designs after they have reached the hardware stage. It is most difficult to do, it is time consuming and often quite costly–if it can be done at all. Certainly, the time to make modifications most effectively is in the prebluepring and blueprint stages.

EXPERIENCE ON THE JOB

At Lockheed, we believe that we have learned a most efficient way of doing this. It cannot be said this knowledge came easily, but it was well worth the effort. It must be confessed that we do not have the experience in the design of remote manipulation equipment that is needed in order to discuss this subject authoritatively; so it will be necessary to fall back on somewhat less related experience. Instead of the remote control of radiation sources, the remote control of supersonic missiles will be discussed.

Some three years ago, the major emphasis was on the optimum design of the cockpit for pilots of high-speed aircraft. At this time, many people doubted that unmanned missiles were here to stay, and even more absurd was the suggestion that human engineers should be working in the missile field. As I recall, the argument ran that if the pilot and crew were removed from the aircraft, human problems were eliminated. Management and a small group of individuals who thought missiles might attain some degree of stature and maturity decided the need for human engineering support was apparent and urgent. Some three years later, it is pleasant to note that at least some of our predictions were borne out. The purpose in mentioning this is not to show how wise we were, but to outline the growing-up process in the hope that this experience may aid efforts in nuclear physics and the general atomic energy field.

At that time, many in the human engineering field were disappointed in the progress that was being made. Convinced that we had something to offer, we were quite limited in trying to get our specialized knowledge converted to hardware. Unfortunately, although the number of expert human engineering personnel increased, and the amount of research data increased, and the number of reports increased, the amount of hardware which reflected good human engineering design did not change appreciably. Because most members of the profession are psychologists, it was a simple matter to rationalize this fact by saying the design engineer was busy with technical problems, and we were not appreciated. Thus, we could go back to our laboratories and ignore the fact that we were falling short of the goal. Looking into the situation at Lockheed, it was found that hardware was created on drawing boards and anything that we wanted to incoporate in the design had to be inserted at this point. There was no guarantee that the contribution would stay in the design, but this was the logical starting point. The first lesson learned was that human engineering personnel had to live with design engineering people. Initial contacts were like trying to mix oil with water, but these experiences were part of a natural growing-up process. It was found that to become part of the design team, human engineering must be treated in the same manner as any other engineering specialty; such as electrical engineering or structural engineering. The implied and indeed required continuous support to the design groups was apparent. Reports and memoranda were not enough to get messages across. The day-to-day exchange of ideas is far more effective and expeditious for this particular purpose. The human engineering personnel at Lockheed work hand-in-glove with design engineers. The human engineering staff issues few reports in connection with any missile project, and those issued deal with things done rather than things to be changed. The operation is run in the same manner as any other line engineering specialty.

DESIGN ENGINEERS' EXPERIENCE UTILIZED

It might be suspected that this philosophy would require a multitude of human engineering specialists. If

there was 1 for say every 4 design engineers, between 300 and 500 human engineering specialists would be needed. We, of course, do not seriously suggest that this is feasible or desirable. To supplement our prime effort, background and experience of design engineers are utilized in all aspects of equipment design. All designers do some human engineering and always have. By maximizing and utilizing this inherent capability, the time and cost requirements of human engineering effort is reduced. There are several ways to make design engineers more effective in this area. The Joint Army–Navy–Air Force Steering Committee has published several chapters of the Joint Services' "Human Engineering Guide to Equipment Design." By using these reports and other human engineering handbooks, such as the "Human Engineering Guide for Equipment Designers," design engineers are able to incorporate certain human engineering data into their hardware design. Recently, Lockheed sent two of its senior design engineers to a week-long Human Engineering Institute. At this Institute, they were instructed in the latest concepts of human engineering and were given a valuable working knowledge of the subject. This training has been valuable in sensitizing and equipping these engineers to supply basic human engineering inputs to hardware design. Returns on this "investment" already have been realized in our surface support department. There are now several institutes conducted around the country.

Just a word of caution about human engineering. A result of our experience in the missile field has been that it is possible to "over human engineer" as well as to "over engineer" equipment. We do not human engineer everything in sight for the sake of human engineering. Rather than making a multitude of special studies on each new situation, it is now possible to draw on research that has already been conducted. As a result, rather than duplicating effort, we use design data which is available in standard human engineering handbooks.

If you are not going to human engineer everything arbitrarily, then there must be some basis for deciding what should be human engineered. Operational experience will provide a prime source. Other sources include job task analysis and the results of operations research studies. Job task analysis provides fairly detailed requirements of job skills. This information, when combined with operational experience will help identify what the man must do in the system and describe the working conditions.

The skill level of the available operator will also be a guide in determining the amount of human engineering effort to be expended. Whereas in the missile business, we are usually designing for the skill levels available in the enlisted ranks of the armed services, requirements may be less stringent elsewhere because of the availability of highly trained engineers, scientists, and technicians.

CONCLUSION

AN ATTEMPT HAS BEEN MADE to present a picture of some of the problems faced in nuclear physics activity and to recount experience in the human engineering field. Frankly, our experience in the combined areas is quite limited. The approach to human engineering problems in related fields leads to the belief that electrical engineering problems are amenable to this type of approach. We do not propose human engineering as a panacea. The problems encountered in day-to-day operations are quite difficult and the solutions will require considerable effort. It is sincerely hoped that this brief exposure will provide encouragement to investigate what human engineering has to offer and to encourage tolerance toward this discipline since psychologists have not been involved in this operation for as long a time as engineers.

Mural in Metal

These artists are hard at work on a "painting in metal." Sculptor Rene Shapshak (*left*) solders a stainless steel bridge girder in place, while artist-designer L. M. Winter fits the span to a section of the 10- by 25-foot panoramic mural in the Pittsburgh Room of the Penn-Sheraton Hotel, Pittsburgh, Pa. To depict 20th Century Pittsburgh, artist Winter chose to work in those industrial media for which the city is famous. He limited his portrait materials to steel, glass, and aluminum. The mural features a stainless steel sheet sky and rivers, stainless steel wire and bar bridges, anodized aluminum sheet buildings and roadways, and glass end panels. Co-operating in providing modern materials suitable for contemporary art were United States Steel Corporation, Aluminum Company of America, and Pittsburgh Plate Glass Company.

A New Video Differential Phase and Gain Equalizer

J. H. CLARK
MEMBER AIEE

ONE OF THE MAJOR PROBLEMS in the transmission of color television signals, of the National Television System Committee type in present use, is that of securing satisfactory differential phase and gain characteristics.

The term "differential gain" refers to the linearity of the system with respect to the instantaneous signal amplitude, and "differential phase" refers to the changes in high frequency delay time which are caused by lower frequency amplitude changes.

Fig. 1 is a schematic circuit of the simplest form of the new equalizer, and Fig. 2 is a vector diagram of the voltage relationships involved. The principle used is that of providing an equal and opposite distortion of the signal in order to compensate for the original distortion.

Vector E shows the input signal voltage and E_1 is the voltage at the output of the attenuator. These voltages remain in phase at all frequencies.

Diodes *D1* and *D2* are conducting on positive excursions of the signal and, inasmuch as they are nonlinear devices, their conductivity is a function of the signal level. When the slider of potentiometer *P1* is near the center of its range there is no effect on the circuit because of the high resistance in series with each diode. As the slider of *P1* is moved downward, diode *D2* begins to provide a shunt path across the input, reducing the length of vector E on positive peaks.

If the slider of *P1* is moved upward, diode *D1* begins to conduct on positive signal peaks, shunting the series element of the attenuator and increasing the length of vector E_1 on positive peaks. The setting of *P1* thus provides a controllable nonlinear expansion or compression of the positive signal peaks.

Diodes *D3* and *D4* with the potentiometer *P2* provide a similar action on negative signal peaks.

Because this part of the equalizer is not frequency sensitive, it can also be used to correct nonlinear distortion in audio, data, telemetering, or other equipment, provided that there is no significant change in the phase relationship of the fundamental frequencies and their harmonics between the source of the distortion and the equalizer. This can be accomplished by inserting the equalizer just ahead or just behind the distortion source or by providing delay equalizers on long circuits.

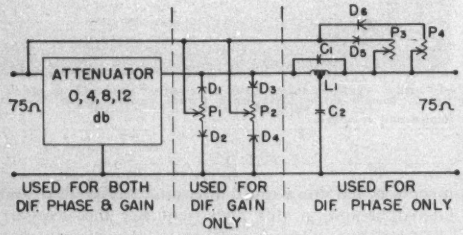

Fig. 1. Attenuator type video differential phase and gain equalizer circuit.

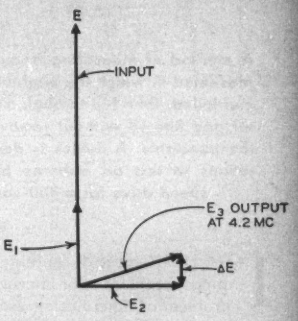

Fig. 2. Vector diagram of phase equalizer voltages.

Referring again to Fig. 1, the all pass phase-shifting network composed of L_1, C_1 and C_2 causes a phase shift of approximately 90 degrees at 4.2 mc, in the color carrier region of the signal, with negligible effect at low frequencies.

The conductance of diodes *D5* and *D6* is therefore largely controlled by the low frequency positive and negative signal voltage excursions, but their effect is to add a controllable nonlinear phase shift in the color carrier frequency region. This is shown in Fig. 2 where the vector E_1 is displaced to position E_2 by the phase-shifting network, and the addition of ΔE through the diodes *D5* or *D6* and potentiometers *P3* or *P4* displaces E_2 to position E_3.

Fortunately, the differential phase correction usually required is such that only one direction of correction is needed. Of course, more complicated arrangements can be designed which correct in both directions, or additional sections using biased diodes can be added for more perfect curve fitting. Another arrangement is also in use which uses an amplifier to provide the necessary voltage differences instead of an attenuator, thus avoiding the introduction of loss in the circuit.

Digest of paper 57-919, recommended by the AIEE Television and Aural Broadcasting Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, Pasco, Wash., Aug. 28-30, 1957. Scheduled for publication in AIEE *Communication and Electronics*. 1957.

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400-Cycle Transient Frequency Meter

F. E. DICKEY

A method of measuring frequency transients is presented in which the original frequency is first multiplied, then fed through a tuned discriminator and filtered without removing or smoothing the transients. A device is described using this means to test an airborne hydraulic constant speed drive for a 400-cps alternator.

THE DESIGNER of constant speed drives and frequency regulators for alternators is faced with the problem of determining exactly how much transient frequency change his system allows in the generated frequency as load varies and the speed of the driving source changes. Lissajou's figures will not suffice because they cannot be read under transient conditions and countertype frequency meters are not fast enough because their circuits require averaging over so much time that they smooth out the transients. Tachometers offer some aid but often there is no way of attaching one to a totally enclosed drive system.

The discriminator type of frequency meter as described in this article and shown in Fig. 1, was developed to measure frequency change transients in a new line of constant-speed alternator drives by using the 400-cps (cycles per second) line voltage out of the generator as its only source of signal. The system is applicable for use in test equipment for measuring frequency transients in oscillators and similar devices. Fig. 2 shows sample curves which were taken as a typical constant speed drive was loaded and unloaded. The meter operates by multiplying the frequency of the input signal by many times up to a high frequency where it can be discriminated and smoothed without filtering out rapid transients.

Fig. 1. Transient frequency meter in use.

THEORY OF OPERATION

IT WAS DESIRED to have a frequency measuring system which would accurately reproduce transient changes in the 400-cps line which have time constants as short as 0.01 seconds. This means that the system would have to be flat to considerably over 16 cps. The means of doing this was to multiply the 400 cps up to 6,400 cps so that it could be fed into a tuned discriminator, rectified, and filtered because at this high frequency the necessary filters could provide a smooth output whereas their time constants would be short enough to prevent the smoothing out of the transients. A further requirement is that the device should not be affected by the line voltage transients which usually accompany the frequency transients.

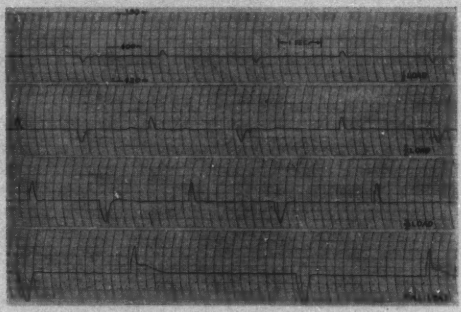

Fig. 2. Sample curves taken as a typical constant speed drive is loaded and unloaded.

Inasmuch as the output of a full-wave rectifier contains a large amount of second harmonic, four of these were placed in cascade to effect the necessary multiplication with buffers and filters in between. The 6,400-cps signal obtained by this means drives a tuned discriminator which feeds an output to a recorder through an adding cathode follower.

A special article recommended by the AIEE Air Transportation Committee.

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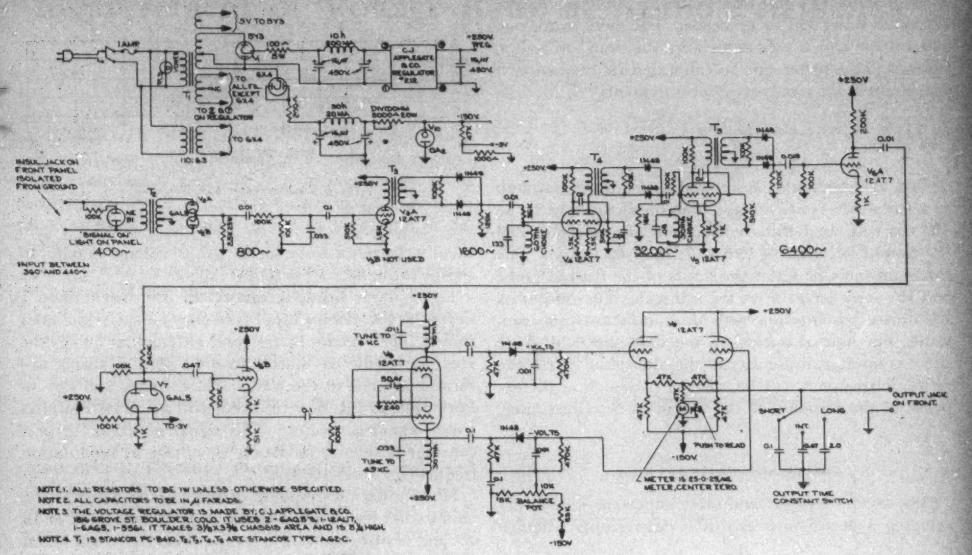
The author wishes to acknowledge the suggestions made by T. E. Coppinger and H. P. Featherstone which helped in the development of this device, and the fact that J. T. Adamchick built and tested it.



NOTE 1. ALL RESISTORS TO BE 1W UNLESS OTHERWISE SPECIFIED.
NOTE 2. ALL CAPACITORS TO BE IN μf FARADS.
NOTE 3. THE VOLTAGE REGULATOR IS MADE BY: C.J. APPLEGATE & CO. 1864 GROVE ST. OAKLAND, CALIF. IT USES 2 - 6AQ5 & 1 - 12AU7, 1 - 6AQ5, 1 - 5Y3GT. IT TAKES 3½ x 3½ CHASSIS AREA AND IS 3½ HIGH.
NOTE 4. T_1 IS STANCOR PC-8410. T_2, T_3, T_4, T_5 ARE STANCOR TYPE A-8E-C.

Fig. 3. 400-cps transient frequency meter.

CIRCUIT

THE ENTIRE CIRCUIT of the device is shown in Fig. 3. A conventional full-wave power supply is used to obtain the d-c while a plug-in unit regulates and smooths it.

Table I. Output Voltage vs A-C Input Voltage while the Input Frequency was Held at 440 cps

A-C Input Volts RMS	D-C Output
60	+2.3
70	2.3
80	2.3
90	2.3
100	2.3
110	2.3
115	2.3
120	2.3
130	2.3
140	2.25
150	2.2

The 400-cps input is full-wave rectified and multiplied four times up to 6,400 cps. Filtering is used between the various stages to pick out the fundamental. Simple R/C (resistance capacitance) filtering is not good enough because if the line voltage is distorted, which is the usual case, the two halves of the first rectified signal will not be equal and although the voltage is filtered with low pass R/C filters from there on, the unbalance still is carried through and becomes worse with subsequent multiplication. The L/C (inductance capacitance) filters which were used reduce the low-frequency response of the amplifier–filter sections so that a much better sine wave is obtained after each multiplication. Of course, these filter inductors are low "Q" r-f chokes in order to obtain the necessary passband.

The full-wave rectified output of the 3,200-cps stage (which is now essentially all 6,400 cps) is amplified and clipped at a ±3-volt level so that the output of V_{6B} is a series of 6,400-cps rectangular pulses. Originally, these were filtered to obtain a 6,400-cps sine wave but it turned out that this is not necessary because the tuned circuits in the discriminator will perform that job adequately.

Tube V_8 and its two L/C combinations comprise the actual discriminator. The circuits are tuned as shown on Fig. 3. The output of each is rectified and fed to a cathode follower adding circuit. A d-c balance is provided for adjusting the output to zero volts when the

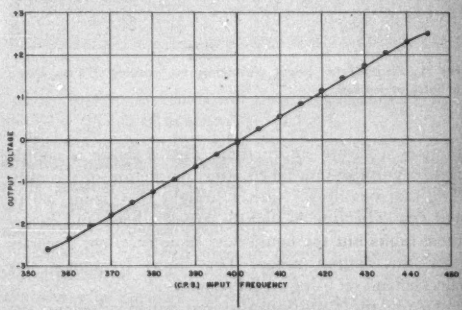


Fig. 4. Discriminator calibration curve.

input is at 400 cps. The total voltage is fed to the output terminals to be sent to a recorder. The meter reads output voltage and is used to balance the signal to zero at 400 cps. This meter can be calibrated in frequency, if it is desired, for steady-state measurements.

OPERATION

THE DEVICE should be allowed a 15-minute warm-up to settle down ready for use. The input must be set to 400 cps with an E-Put counter or reed-type meter and the output adjusted to zero with the balance pot. The input can now be set at the limits of the desired range and the recorder gain set for full scale. The output of the device has filtering with three different time constants. For normal operation, the short one is used. If there is noise or instability in the alternator either one of the longer ones may be selected, although at the expense of the response of the system as described later.

TESTS AND CALIBRATIONS

ONE OF THE HARDEST and most important jobs in developing a device such as this is determining whether

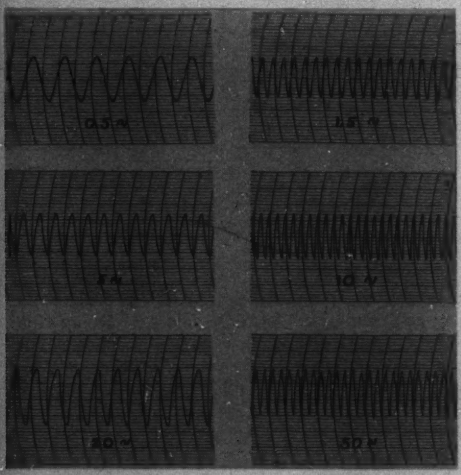


Fig. 5. Discriminator output waveforms for constant ±5-cps swing at rates as marked.

it gives accurate information. Fig. 4 shows a sample linearity calibration taken after completion of the unit. The line was drawn with a straight edge from 360 to 440 cps. The line is slightly curved above and below these limits but the figure does show excellent linearity over the desired range. The input frequency was checked and set using an E-Put meter.

To test the sensitivity to input voltage changes, the information in Table I was obtained. This table shows

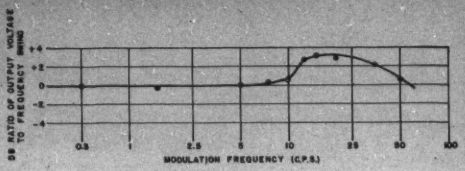


Fig. 6. Discriminator response curve.

the discriminator to be insensitive to voltage changes in the a-c input over all practical ranges.

Fig. 5 shows brush recordings of the discriminator's output as the 400-cps input is swung ±5 cps at the rates shown. The waveforms are good although at 50 cps the recorder needle has started to drag a little causing distortion in some of the waves. These curves and the information in Fig. 6 were taken with a special FM electronic signal generator.[1] This signal generator gives a constant frequency deviation vs voltage at modulation frequencies up to 100 cps.

Fig. 6 gives the response of the discriminator as the modulation frequency is changed. It shows a peak at 15 cps and is still good out to 50 cps. This curve was taken with the output filter on "short" time constant. At the middle position, the curve falls off above 25 cps and on the "long" setting it drops off above 10 cps.

REFERENCE

1. F.M. Signal Generator, F. E. Dickey. *Electronic Equipment*, Nov. 1954, p. 8.

Balloon Guidance System

Functional and environmental tests at near 90,000-foot altitudes (about 17 miles) have been successfully accomplished on electromechanical components for guidance and control systems designed and developed by Autonetics, a division of North American Aviation, Inc.

The tests were carried out with the components mounted in a metal-framed gondola carried aloft by a huge, helium-filled balloon. In all, four flights were made from the flight test center at New Brighton, Minn., operated by General Mills, Inc.

In the longest of these test flights, the balloon traveled to the vicinity of Des Moines, Iowa, where the gondola was safely parachuted back to earth. Other flights ranged between 60 and 100 miles east and west of Minneapolis, Minn., before the equipment under test descended to earth.

The specially designed, equipment-carrying gondola was produced by Autonetics' engineers and metal-working specialists. General Mills personnel provided the balloon and were responsible for handling and launching operations.

Measurement of Voltage Ratio at Audio Frequencies

W. C. SZE

ACCURATE MEASUREMENTS in voltage ratios and phase angles are essential in computer applications. A method of verifying these measurements, to an accuracy of 0.005% in voltage ratio and 0.2 minute in phase angle at frequencies of 100 to 10,000 cps, is described.

The measuring circuit (Fig. 1) consists of a symmetrically arranged resistance-capacitance network (C_1 R_1 C_2 and R_2) plus the guard circuit consisting of a similarly arranged network (C_{g1} R_{g1} C_{g2} and R_{g2}). These circuits are successively balanced by adjusting either C_1 R_1 or C_2 R_2 for the measuring circuit and either C_{g1} R_{g1} or C_{g2} R_{g2} for the guard circuit until the detector D indicates a null in both positions.

The a-c resistors R_2 and R_1 are not stable to the accuracy desired. Therefore, the ratio R_2/R_1 is determined immediately after each a-c balance by using a highly accurate d-c Wheatstone bridge, from which S_2/S_1 is adjusted to be equal to R_2/R_1. Precision d-c standard resistors are used for S_2 and S_1. They are carefully selected and arranged in the circuit to limit the circuit errors and unknown variables to less than 0.002%.

Because the voltage ratio is derived from measurements with d-c resistance standards, it is necessary to know the change of effective resistance of the a-c resistors R_2 and R_1 with frequency. Although these corrections μ_{R2} for R_2 and μ_{R1} for R_1 are very small, they cannot be neglected. They arise from skin effect, dielectric loss, and the residual reactances which inevitably are associated with all resistors and become increasingly important as the test frequency is raised. Parallel-wire reference standards of computable reactance and effective resistance were used in a bridge circuit to determine μ_{R2} and μ_{R1}. The voltage ratio is computed from the following equation:

$$\text{Voltage Ratio} = \left[\frac{S_2}{S_1}(1+\mu_{R2}-\mu_{R1})+1\right]\frac{1}{(\cos\gamma+\omega R_2 C_2 \sin\gamma)}$$

It is very difficult to measure accurately the absolute values of capacitors, C_2 and C_1, and nearly impossible to measure the stray capacitances in parallel with these capacitors. An elaborate substitution method was therefore devised for evaluating the phase angle. After a null balance is determined from circuit of Fig. 1, the values of R_1, R_2, and C_1 are left fixed, and low-loss capacitors C_2'' and C_1'' are connected in place of the ratio transformer or a-c divider as shown in Fig. 2. A new null balance is obtained by varying C_2'' or C_1'' and a slight adjustment of C_2 to a new value C_2'. The phase angle γ is determined from the settings of C_2.

$$\gamma = \frac{\omega R^2_2}{R_2 + R_1}(C_2 - C_2') \text{ radians.}$$

Therefore, measurements of absolute values of C_2, C_1, and stray capacitances are not necessary.

However, in order to use the foregoing described substitution method, the construction of two low-loss, three-terminal, air capacitors C_2'' and C_1'' was necessary. Their measured dielectric loss angle was approximately one second at 1,000 cps.

The setup has been used in checking transformers and dividers for voltage ratio up to 1,000/1. Fractional ratios may be measured as readily as integral ratios.

The over-all resolution is better than one microvolt.

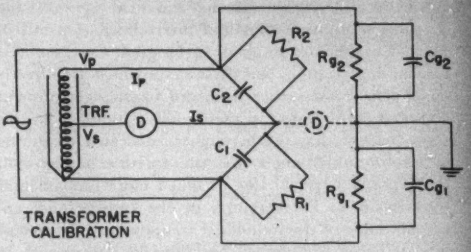


Fig. 1. Transformer calibration circuit.

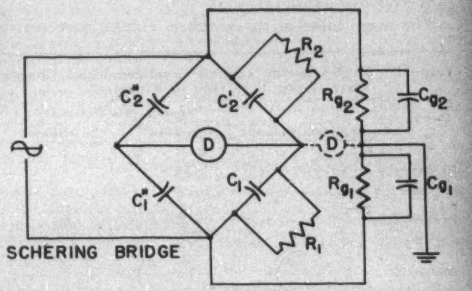


Fig. 2. Schering bridge circuit.

Digest of paper 57-648, recommended by the AIEE Special Instruments and Auxiliary Apparatus Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Montreal, Que., Canada, June 24-28, 1957. Scheduled for publication in AIEE *Communication & Electronics*, 1957.

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This investigation of voltage ratio measurements was conducted under a co-operative program of basic instrumentation research and development sponsored by the NBS, the Office of Naval Research, the Office of Scientific Research of the Air Research and Development Command, and the Atomic Energy Commission.

The author wishes to acknowledge the valuable help and advice received from F. L. Hermach of NBS.

Some New Mathematical Aspects of Fixed Charges

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FROM STUDIES of the mathematical aspects of the three most important and interrelated elements of Fixed Charge rates in terms of Original Cost, namely: return, depreciation, and those taxes which are directly dependent upon such return and upon the treatment accorded depreciation in their computations, it has become evident that the heretofore advocated technique of levelization of their basically variable nature with time is only a special case of much more fundamental considerations. Furthermore, in the conventional approach, some of the individual components of the total rate of Fixed Charges do not describe properly their own economic significance. The formulas which were developed by the new approach, however, express each individual component in a manner descriptive of its own economic nature.

The magnitudes of the levelized Fixed Charge rates will differ depending upon the length of period selected for their levelization. But levelized Fixed Charge rates calculated from year one to eternity provide results which are well within acceptable practical engineering accuracies for most types of investment growth laws and for plant life spans of more than 100 years. This point is demonstrated in Fig. 1 for four different geometric growth rates.

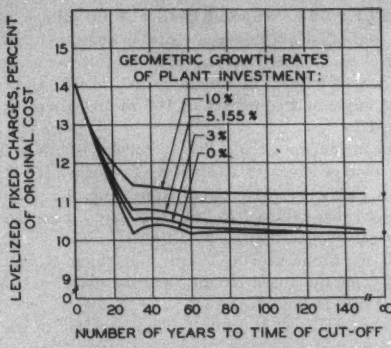

Fig. 1. Taxes based on straight-line depreciation.

Table I. Formulas for Annual Levelized Fixed Charge Rates from Year One to Eternity*

		Approximate Methods	
	Complete Method†	Simplified	Conventional
(1) Return	$\frac{r}{r'}\left(r' + p\bar{a}_{\overline{Lr'}} - \frac{p}{L}\right)$	Kr	
(2) Depreciation	$\frac{p}{L}$	$\frac{p}{L}$	$p\bar{a}_{\overline{Lr}}$
(3) Taxes	$\frac{T}{1-T}\left(1-\frac{ib}{r}\right)\frac{r}{r'} \times \left(r' + p\bar{a}_{\overline{Lr'}} - \frac{p}{L}\right)$	$\frac{T}{1-T}\left(1-\frac{ib}{r}\right)Kr$	$\frac{T}{1-T}\left(1-\frac{ib}{r}\right) \times \left(r + p\bar{a}_{\overline{Lr}} - \frac{p}{L}\right)$
(4) Total	Lines (1)+(2)+(3)	Lines (1)+(2)+(3)	Lines (1)+(2)+(3)

where

r = Constant average annual return rate, which is equal to the average ratio of the annual earned return requirements for the security holders to the invested capital provided by them (debt, preferred stock and common stock equity, including surplus).

r' = Constant annual earned discount return rate for the "money source" which is considered to supply the funds required for a particular project in order to levelize rationally the series of variable annual charges to an equivalent levelized annual charge. With the utility being the "money source" it is equal to $(r\text{-}Tib)$.

p = A constant equal to the ratio of the original cost less its net salvage at the end of the useful life of the project to the original cost. Net salvage is equal to the salvage value of the project less the cost of removal.

L = Average life expectancy of the project or facilities expressed in years.

K = An empirical constant, to be established after consideration of all pertinent facts. Its general level can be gauged from a study of past and estimated future ratios of the magnitudes of the net depreciable plant to the total of its original cost. It ordinarily will lie within the range between 0.7 and 0.8 for the bulk of life expectancies of facilities used on electric utility systems ranging from 30 to 50 years.

T = Constant composite effective average annual income tax rate combining the Federal income tax rate, state income tax rate, and any other tax rate dependent on income.

i = Constant average annual interest rate on the indebtedness of the enterprise.

b = Constant average ratio of indebtedness of the enterprise to its total invested capital.

$\bar{a}_{\overline{Lr'}}$, $\bar{a}_{\overline{Lr}}$ = The group annuity portion of depreciation, reflecting the effects of retirement dispersion, obtained from special group-basis annuity tables‡ at a discount return rate of r' and r, respectively.

*Apply to conditions when taxes are computed using straight-line depreciation.

†When the compound growth rate g_C is greater than r', g_C should be substituted for r' in all terms of the formulas including $d_{\overline{Lr'}}$.

‡See "The Depreciation Annuity," P. H. Jeynes. AIEE *Transactions*, vol. 75, pt. III, 1956 (Feb. 1957 section), pp. 1398-1410.

In view of the existing income tax laws, the discount rate used in the levelization of variable charges with time should be the rate of return on invested capital reduced by the effect of tax exemption on that portion of such return rate which is represented by the interest requirements of debt capital. But levelized Fixed Charge rates calculated using discount factors which do not reflect such a reduction, under generally prevailing financial and other conditions encountered in present-day utility system practices, will provide results which are within acceptable practical engineering accuracies.

Formulas based on the new complete method have been developed and are shown in column 1 of Table I. Since almost all factors entering into these formulas are basically established from enlightened judgment, and since annuity tables reflecting retirement dispersion are not always available, simplified formulas are shown in column 2 and should be adequate for day-to-day use. For convenience, formulas for the "conventional" method are also included in column 3 of this table.

Digest of paper 57-152, recommended by the AIEE System Engineering Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, Jan. 21-25, 1957. Published in AIEE *Power Apparatus and Systems*, June 1957, pp. 230-49.

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INSTITUTE ACTIVITIES

Technical Committees Announce Plans for 1958 AIEE Winter General Meeting

THIS YEAR the Sheraton-McAlpin Hotel, as well as the Statler Hotel, will be used for technical sessions and committee meetings in connection with the AIEE Winter General Meeting, February 2-7, 1958.

At this writing, 42 technical committees in the 6 Divisions have announced plans for 96 technical sessions. In the Power Division, the Rotating Machinery and Transmission and Distribution Committees have scheduled five sessions each. There will be four sessions sponsored by the Transformers Committee and three sessions by the Insulated Conductors Committee. The System Engineering Committee will present individual sessions and joint sessions with Power Generation and Computing Devices Committees. In addition, the Power Generation, Power System Communications and Protective Devices Committees also are arranging for one or more sessions. The Substations and Switchgear Committees will have a joint session in addition to their individual sessions.

Committees in the Communication Division have announced a joint session on Data Communication and Telegraph Systems, Radio Communication and Television and Aural Broadcasting and Telegraph Systems and Wire Communication. Other sessions in this Division will include Communication Switching and Communication Theory.

In the Industry Division, technical meetings on Industrial Power Rectifiers and Systems, Industrial Control, Electric Welding, Mining and Metal Industry, and Petroleum Industry are planned. Four sessions each by Feedback Control and Chemical Industry will be presented along with a joint session by Chemical Industry and Electric Heating.

The Committees in the Science and Electronics Division also are organizing sessions on Nucleonics, Basic Sciences, Dielectrics, Electrical Techniques in Medicine and Biology, Electronics, Magnetic Amplifiers, Metallic Rectifiers, and Solid-State Devices.

Other sessions, announced by Committees in the Applications Division, are Marine Transportation, Domestic and Commercial Applications, and Production and Application of Light. In the Instrumentation Division, sessions are being planned on Electronics and High Frequency Instruments and Recording and Controlling Instruments.

Among the General Committees of the Institute, sessions are being organized on Research and Safety.

Informal Tea

This social gathering before the formal program begins has been enjoyed by more and more people each year. Make it a point to attend this year—Sunday afternoon, February 2, from 4 to 6 p.m., in the Georgian Room of the Statler. There will be no charge.

During this period, the registration facilities will be open for those wishing to avoid the Monday morning rush.

Hotel Reservations

Blocks of rooms have been set aside at the Statler and nearby hotels for members and guests attending the meeting. Members should send requests for reservations to the hotel of their choice, specifically referring to the AIEE meeting in their letter. Please do not write to more than one hotel. If requests cannot be filled, the hotel will automatically refer requests to the Hotel Accommodations Committee whose duty it is to obtain a similar reservation at another of the convention hotels. The hotel will confirm directly to the member. No guarantee that members will be housed satisfactorily can be made if requests are received after January 13, 1958.

Because of the crowded conditions in New York hotels, it is suggested that reservations be made for arrival on Sunday February 2, 1958, thereby avoiding delays in registration or unavailability of rooms in the early morning of subsequent days. It is also suggested that a request for reservations prior to Christmas is more likely to be filled.

Rooms have been allotted for AIEE use by the following hotels at the daily rates indicated below:

Hotel Statler (meeting headquarters), 7th Ave., 32nd to 33rd St.			
Single Room	$ 8.00	to	$14.00
Double Room	11.00	to	18.00
Twin Bedroom	15.00	to	22.00
Suites	36.00	to	37.00
Hotel Sheraton-McAlpin (also used for meetings), Broadway and 34th St.			
Single Room	$ 6.85	to	$14.85
Double Room	10.35	to	17.85
Twin Bedroom	13.35	to	18.85
Suites	25.00	to	32.00
Hotel New Yorker, 8th Ave. at 34th St.			
Single Room	$ 8.00	to	$13.00
Double Room	11.50	to	16.50
Twin Bedroom	14.50	to	19.50
Suites	24.00	and up	
Hotel Martinique, Broadway and 32nd St.			
Single Room	$ 6.50	to	$11.00
Double Room	9.50	to	14.50
Twin Bedroom	9.50	to	14.50
Hotel Commodore, Lexington Ave. and 42nd St.			
Single Room	$ 7.00	to	$14.00
Double Room	12.00	to	17.00
Twin Bedroom	12.00	to	18.00

A LARGE liquid propellant rocket engine is fired in Reaction Motors, Inc. (RMI), new one-million pound thrust test stand at Lake Denmark, N. J. This stand, capable of firing engines in any flight attitude, is believed to be the largest of its kind in the world. Over seven million pounds of concrete were poured to create the massive structure which is integrated with the bedrock in the mountainous area. The stand is fully instrumented for recording and evaluating the performance of latest rocket engine designs. It is one of more than 20 stands operated by RMI in the development of rocket engines for aircraft, missiles, and other applications. An inspection trip to RMI will be held during the 1958 Winter General Meeting.

Hotel Roosevelt, Madison Ave. and 45th St.	
Single Room	$10.50 to $13.50
Double Room	16.00 to 19.00
Twin Bedroom	18.50 to 21.50

All rooms have private bath and the rates quoted are subject to a 5% New York City hotel room tax.

Smoker

A highlight of the Winter General Meeting will be the Smoker to be held Tuesday evening, February 4, 1958. Good food, good fellowship, and top quality entertainment will be the feature of this event which will take place in the Hotel Statler.

Attendance will be limited for the comfort of guests. Ticket requests should be mailed at an early date. The price will be $11 per ticket and requests should be addressed to "AIEE Smoker Committee," 33 W. 39th St., New York 18, N.Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Dinner-Dance

A Dinner-Dance will be held Thursday evening, February 6, in the Grand Ballroom of the Hotel Statler. General arrangements will be the same as those which proved enjoyable last year. Dress will be formal. Write soon for reservations for tables for 10. The price this year is $12.50 per ticket and requests should be sent to "AIEE Dinner-Dance Committee" at 33 W. 39th St., New York 18, N.Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Inspection Trips

A full program of approximately 20 morning and afternoon inspection trips is being arranged for Tuesday, Wednesday, and Thursday of the meeting week. Among the locations to be visited are Radio City Music Hall, Ford Plant at Mahwah, N.J., Consolidated Edison's East River Generating Station, and the Bell Telephone Laboratories at Murray Hill on Tuesday. Reaction Motors and Long Island Lighting Company's new Barrett Generating Station are now scheduled for Wednesday, with Brookhaven National Laboratories, Western Electric Kearney Plant, Public Service of New Jersey's New Linden Generating Station in the Thursday group.

Additional tours to Sikorski Helicopter Plant, Federal Pacific Electric Co., a color television studio, Westinghouse Lamp Works at Bloomfield, N.J., and the Holophane Light and Vision Institute are being arranged.

Heavy emphasis is being given to power plants. A trip each day is scheduled to one of the local generating stations enabling visitors to see the outstanding features of these newer installations. Excellent coverage is also given to the illumination field with the Westinghouse Lamp Works, the color television studio, and Holophane's Light and Vision Institute tours.

A complete and definite schedule will appear in the January issue.

Advance registration will be accepted from *out-of-towners only* for the Bell Telephone Laboratories Tour on Tuesday, Reaction Motors Plant on Wednesday, and the Brookhaven Laboratories on Thursday. There will be no advance registration for local AIEE members.

Theater Tickets

This year, a different system will be followed for several reasons, and your cooperation is needed. Requests for tickets should be sent directly to the agency, not to an AIEE committee.

The listing of shows available is being delayed until the January issue of this magazine and mailing of the flyer, in order to assure a full and meaningful list. The agency will set aside blocks of tickets for AIEE use and will fill members' order on a first-come first-served basis. All tickets will be left at the box office in the name of the purchaser.

Radio and television tickets will be available as usual at the information desk.

Ladies Entertainment

The Ladies Entertainment Committee under the chairmanship of Mrs. C. T. Hatcher is arranging what it hopes will be an interesting program for the Winter General Meeting of the AIEE.

The Coffee Hour and a Get-Acquainted Tea will start off the week's activities on Monday, followed by a United Nations tour, a New York City tour with stops at points of interest, a dinner party with entertainment and prizes, a luncheon and style show at the Waldorf-Astoria, breakfast at Altman's, and other planned activities.

Each lady must register with her husband first, then bring her badge to Ladies Headquarters to register for participation in the Ladies' program. Registration will start Sunday afternoon, February 2, 1958, from 2 to 4 p.m. at Ladies Headquarters in the Washington Room at the Hotel Statler.

Winter General Meeting Committee

Members of the 1958 Winter General Meeting Committee are: D. M. Quick, chairman; R. T. Weil, Jr., vice-chairman; J. J. Anderson, secretary; L. F. Stone, budget co-ordinator and AIEE vice-president for District No. 3; Hendley Blackmon, chairman, Technical Operations Department; J. A. Parrott, public relations; R. W. Gillette, general session; D. E. Winslow, hotel accommodations; T. C. Oliver, registration; J. A. Mulligan, inspection trips; R. R. Meola, monitors; H. B. Snow, smoker; W. F. Anselm, dinner-dance; Mrs. C. T. Hatcher, ladies entertainment; A. J. Cooper, ex-officio member (past-chairman).

Sperry Award Presentation Is One of Many Events at AIEE Fall General Meeting

OVER 1,900 MEMBERS, their wives, and guests attended the AIEE Fall General Meeting, held October 7-11, 1957, at the Morrison Hotel, Chicago, Ill.

Sperry Award Presentation

An outstanding feature of the Fall Meeting was the presentation of the 1957 Elmer A. Sperry Award at a special luncheon held Thursday, October 10. The Sperry Board of Award, composed of two representatives each of AIEE, the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Society of Naval Architects and Marine Engineers annually presents the award in recognition of a distinguished engineering contribution which has advanced the art of transportation. The board conferred the honor this year on engineers of the Electro-Motive Division, General Motors Corporation, ". . . for developing the Diesel-electric locomotive which helped revolutionize American railroading."

Those honored included H. L. Hamilton, retired vice-president of General Motors and founder of Electro-Motive; R. M. Dilworth, retired, who was chief engineer from 1926 to 1951; and E. W. Kettering, now director of research of Electro-Motive. Also honored were various sections of the engineering department. Representatives accepting these awards included L. O. Parker, mechanical engineering section; Ludwig Petersen, locomotive section; and T. O. Lillquist, controls section. The awards were presented by R. B. Lea, a director of Sperry Products, Inc., and chairman of the Sperry Board of Award.

Entertainment and Trips

An interesting social program, held in conjunction with the meeting, included a reception tea on Sunday, the Fall Frolics on Wednesday evening, and a number of luncheons, tours, and card parties for the ladies under the chairmanship of Mrs. F. M. McCloska aided by Mrs. D. H. Beal and Mrs. J. F. Bracken.

Inspection trips were made to the Electro-Motive Division of General Motors, Commonwealth Edison, several shopping centers in the Chicago Area, Argonne National Laboratories, Will County Generating Station, Automatic Electric Company, Youngstown Sheet and Tube Company, and the Columbia Broadcasting System's new Chicago headquarters.

General Session

The general session, held Monday afternoon at the Morrison Hotel ballroom, was called to order by E. G. Norell, chairman of the Chicago Section, who introduced G. L. Welch, chairman of the Fall General Meeting Committee. Following a brief address and introduction of several meeting committee representatives, Mr. Welch presented T. G. Ayers, vice-president, Commonwealth Edison Company, who gave the welcoming address. He stated that the Institute's standards of professionalism are important not only to the welfare of the community, but also to the welfare of its membership. The

AIEE Future Meetings

AIEE-IRE-ACM Eastern Joint Computer Conference* (Exhibit)
Park Sheraton and Shoreham Hotels
Washington, D. C.
December 9-13, 1957

AIEE-IRE-ASQC Reliability and Quality Control Conference*
Statler Hotel, Washington, D. C.
January 6-8, 1958

AIEE-IRE-AEC-NBS Scintillation Counter Symposium*
Shoreham Hotel, Washington, D. C.
January 27-28, 1958

Winter General Meeting*
Hotel Statler, New York, N. Y.
February 2-7, 1958

AIEE-IRE-U of P Transistor and Solid State Circuits Conference
Philadelphia, Pa.
February 20-21, 1958
(Final date for †TP—closed, ‡CP Syn.—Dec. 3, CPMs—Dec. 13)

Textile Conference
Georgia Institute of Technology
Atlanta, Ga.
March 13-14, 1958
(Final date for †TP—Dec. 3, ‡CP Syn.—Dec. 26, CPMs—Jan. 7)

American Power Conference
Sherman Hotel, Chicago, Ill.
March 17-19, 1958
(Final date for †TP—Dec. 6, ‡CP Syn.—Jan. 1, CPMs—Jan. 10)

EJC Nuclear Congress
International Amphitheatre
Chicago, Ill.
March 17-21, 1958
(Final date for †TP—Dec. 6, ‡CP Syn.—Jan. 1, CPMs—Jan. 10)

AIEE-ASME Engineering Management Conference
Boston, Mass.
March 19-20, 1958
(Final date for †TP—Dec. 9, ‡CP Syn.—Jan. 3, CPMs—Jan. 13)

Pulp and Paper Conference
North Carolina State College
Raleigh, N. C.
March 27-29, 1958
(Final date for †TP—Dec. 20, ‡CP Syn.—Jan. 15, CPMs—Jan. 24)

South West District Meeting
Tulsa, Okla.
March 31-April 2, 1958
(Final date for †TP—Dec. 20, §DP Syn.—Jan. 8, DPMs—Jan. 13)

AIEE-ASME Railroad Conference
Cleveland, Ohio
April 9-10, 1958
(Final date for †TP—Dec. 30, ‡CP Syn.—Jan. 24, CPMs—Feb. 3)

Rubber and Plastics Conference
Mayflower Hotel
Akron, Ohio
April 14-15, 1958
(Final date for †TP—Jan. 3, ‡CP Syn.—Jan. 28, CPMs—Feb. 7)

AIEE-IRE-ASME Automatic Techniques Conference (Automation and Data Processing)
Statler Hotel
Detroit, Mich.
April 14-16, 1958
(Final date for †TP—Jan. 3, ‡CP Syn.—Feb. 25, CPMs—Feb. 7)

AIEE-IRE-RETMA-WCEMA Joint Electronic Components Conference
Los Angeles, Calif.
April 22-24, 1958
(Final date for †TP—Jan. 10 ‡CP Syn.—Feb. 5, CPMs—Feb. 15)

Middle Eastern District Meeting
Washington, D. C.
April 28-30, 1958
(Final date for †TP—Jan. 17, §DP Syn.—Feb. 7, DPMs—Feb. 11)

Great Lakes District Meeting
Michigan State University
East Lansing, Mich.
May 5-7, 1958
(Final date for †TP—Jan. 24, §DP Syn.—Feb. 7, DPMs—Feb. 11)

AIEE-IRE-ACM Western Joint Computer Conference (Exhibit)
Ambassador Hotel
Los Angeles, Calif.
May 6-9, 1958
(Final date for †TP—Jan. 24, ‡CP Syn.—Feb. 18, CPMs—Feb. 28)

East Central District Meeting
Huntington, W. Va.
May 13-15, 1958
(Final date for †TP—Jan. 31, §DP Syn.—March 7, DPMs—March 11)

Materials Handling Conference
Pittsburgh, Pa.
May 19-20, 1958
(Final date for †TP—Feb. 7, ‡CP Syn.—March 4, CPMs—March 14)

Domestic Appliances Conference
Hotel Morrison
Chicago, Ill.
May 26-28, 1958
(Final date for †TP—Feb. 14, ‡CP Syn.—March 11, CPMs—March 21)

AIEE-ISA-IAS-ARS National Telemetering Conference (Exhibit)
Lord Baltimore Hotel
Baltimore, Md.
June 2-4, 1958
(Final date for †TP—Feb. 21, ‡CP Syn.—March 18, CPMs—March 28)

Summer General Meeting
Buffalo, N. Y.
June 22-27, 1958
(Final date for †TP—March 14, ‡CP Syn.—April 3, CPMs—April 7)

AIEE-IRE Nonlinear Magnetics and Magnetic Amplifiers Conference (Exhibit)
Los Angeles, Calif.
August 5-8, 1958
(Final date for †TP—April 25, ‡CP Syn.—May 20, CPMs—May 30)

Pacific General Meeting
Sacramento, Calif.
August 19-22, 1958
(Final date for †TP—May 9, ‡CP Syn.—June 3, CPMs—June 6)

Petroleum Industry Conference
Baker Hotel
Dallas, Texas
September 15-17, 1958
(Final date for †TP—June 6, ‡CP Syn.—July 1, CPMs—July 11)

AIEE-IRE-ASME National Power Conference
Boston, Mass.
September 28-October 1, 1958
(Final date for †TP—June 20, ‡CP Syn.—July 15, CPMs—July 25)

AIEE-IRE-RETMA-SMPTE National Electronics Conference
Chicago, Ill.
October 13-15, 1958
(Final date for †TP—July 4, ‡CP Syn.—July 29, CPMs—Aug. 8)

Machine Tools Conference
Statler Hotel
Hartford, Conn.
October 13-15, 1958
(Final date for †TP—July 4, ‡CP Syn.—July 29, CPMs—Aug. 8)

Fall General Meeting
Pittsburgh, Pa.
October 26-31, 1958
(Final date for †TP—June 27, ‡CP Syn.—Aug. 4, CPMs—Aug. 8)

AIEE-IRE-ACM Eastern Joint Computer Conference (Exhibit)
Bellevue-Stratford Hotel
Philadelphia, Pa.
December 3-5, 1958
(Final date for †TP—Aug. 25, ‡CP Syn.—Sept. 19, CPMs—Sept. 29)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
§DP Syn.—District Synopsis
(District Paper Synopses should be directed to the District Meeting Committee)
DPMs—District Manuscript

C. F. KETTERING (*left*), 82, a director of General Motors and himself holder of many of America's top engineering citations, looks on as his son, E. W. Kettering (*right*), director of research, Electro-Motive Division, General Motors, receives a medal signifying young Kettering's part in developing the Diesel-electric locomotive. Father and son were present for the presentation of the Elmer A. Sperry Award to engineers of Electro-Motive Division "for development of the Diesel-electric locomotive which helped revolutionize American railroading." The Sperry Award was presented at the 1957 AIEE Fall General Meeting by R. B. Lea (*center*), a director of Sperry Products, Inc., and chairman of the Sperry Board of Award.

Institute is a bulwark for morale in a period when society, Government, and the economy are changing rapidly and drastically. Its code of ethics is a stronghold for general good at a time when business and living pressures are rising rapidly. It is a stabilizing influence in the changing relationship between labor and management.

Following Mr. Ayers' address, AIEE President W. J. Barrett was introduced. He re-emphasized some of the points he made at the Pacific General Meeting, held August 28-30 in Pasco, Wash. He stated that the Board of Directors' plan for the clear assignment of intersociety activities has been misunderstood and misrepresented. He then reviewed and clarified the Institute view toward the functions of those organizations, such as the Engineers Joint Council, Engineers' Council for Professional Development, and National Society of Professional Engineers, which deal with the problems of the engineering profession as a whole (see *Electrical Engineering*, November 1957, p. 977). In addition, he described briefly the steps leading up to the acquisition of the site for the new United Engineering Center in New York City.

REPRESENTATIVES of engineering societies making presentation of Sperry Award to Electro-Motive Division, General Motors Corp., are (*left to right*) Merrill Bennett, vice-president, Society of Automotive Engineers; C. R. Waller, Society of Naval Architects and Marine Engineers; R. B. Lea, chairman, Sperry Board of Award and director of Sperry Products, Inc.; W. J. Barrett, president, AIEE; Roland Stever, vice-president, American Society of Mechanical Engineers.

Mr. Barrett then introduced W. R. Brownlee, a director of the Institute and chairman of the Recognition Awards Committee, who gave a history of the establishment of the AIEE Medal in Electrical Engineering Education, awarded this year to W. L. Everitt, dean of the College of Engineering, University of Illinois.

Prof. E. C. Jordan, head of the department of electrical engineering at the University of Illinois, then reviewed the career of the Medalist. Following this address, President Barrett presented the award to Dr. Everitt. The text of Dr. Everitt's acceptance speech will be found on pp. 1097-1100 of this issue.

Mr. Welch then presented the principal speaker, R. W. Galvin, president of Motorola, Inc., who gave an address entitled "Tastemakers in an Era of Abundance." He stated that in each era of the nation's history the dominant human force in the economy has had much to do with the shaping of political institutions and social customs. This particular era will probably go down as the "age of the scientist." However, he pointed out, "the overriding need in a science-dominated era of superabundance will be for balance in human relationships."

Technical Sessions

Some 45 technical sessions were presented during the meeting, covering such fields as power generation, system engineering, rotating machinery, radio communications, television and aural broadcasting, land transportation, and power reactor instrumentation.

Among the many sessions were two outstanding ones on transmission and distribution. In these, valuable data were brought out on lightning phenomena and line flashover, particularly with respect to the higher voltage transmission lines.

Industrial Power Systems. A new type of transmission system designed to meet the increasing use of audio frequency power was described by W. A. Munson and A. J. Germain of the Westinghouse Electric Corp., East Pittsburgh, Pa.

During the past decade, the use of audio frequencies has been on the increase not only in kw consumption but in industrial and commercial applications. Because of this increase, the need of using larger centrally located generators becomes an economical requirement. The problem of transmitting these larger blocks of power to a point of utilization has been a field of "tremendous activity."

Of various systems being tried, the con-

centric conductor system, in service at the Ladish Forge Plant in Cudahy, Wis., ". . . has enjoyed a degree of success equal to its original expectations."

Power System Communications. A reliable self-restoring protective system for electric power communication lines can be constructed from presently available devices. In "Protection Equipment for Power Company Communication Lines," D. L. Brown and L. N. Sherban, of the Portland General Electric Co., Portland, Oreg., said that "there is room for improvement of existing devices and development of new ones to provide a very high degree of protection and reliability required for modern, remotely controlled and remotely supervised power systems."

They pointed out that protection methods used by telephone companies are not suited to power-system communication circuits, and that power-company communication lines protection is not standardized but varies widely from company to company.

Safety. Artificial respiration by means of mouth-to-mouth insufflation, a practice recommended since Biblical days, was recommended at a safety symposium. It was termed a superior means of resuscitation in two technical papers, "A Comparison of Mouth-to-Mouth and Manual Artificial Respiration Techniques," and "The Principles and Practice of Emergency Mechanical Resuscitation," both by Drs. C. W. Frye and A. S. Gordon, of the University of Illinois College of Medicine.

Their conclusions follow:

1. With an ideal, unobstructed airway, mouth-to-mouth insufflation has been found to give as effective ventilation as push-pull manual methods of artificial respiration.

2. When an ideal airway is not assured, such as under practical resuscitation conditions, the mouth-to-mouth method is the only nonmechanical technique which assures patent airway.

3. Even the well-performed push-pull manual methods frequently result in partial or complete obstruction of the airway.

4. Mouth-to-mouth insufflation is the preferred nonmechanical method of resuscitation for infants and small children. It should also be used for adults if the rescuer can overlook the esthetic aspects of the situation. Push-pull manual methods are a second choice.

5. For pole-top resuscitation, some method of artificial respiration must be started at once. Mouth-to-mouth and push-pull pole-top resuscitation give the best ventilation and should be employed until a mechanical resuscitator with mask extension can be taken up the pole, or the victim can be lowered to the ground.

Mechanical resuscitators, especially for prolonged use, are of proved value.

Rotating Machinery. An electronic drive controlling the flexible speed of motors is economically and electrically better suited to its ultimate use than would be a comparable drive employing a rotating converting unit, A. J. Humphrey and K. L. Shrider of the Reliance Electric and Engineering Co., Cleveland, Ohio, stated in a paper entitled "A Variable-Speed D-C Motor Drive Employing the Xatron, a Grid-Controlled Mercury-Arc Rectifier."

They described the Xatron drive as being furnished at present in sizes between 30 and 300 hp, with a standard d-c motor having 480 to 500 volts applied to its armature at base speed and having 250 volts for field excitation. Armature voltage is obtained directly from a 3-phase 440-volt line by way of a 6-phase bridge rectifier. The motor field is supplied from a controlled thyratron half-wave rectifier with gas diode back rectifier.

K. G. Black and R. J. Noorda, of General Electric Co., Schenectady, N. Y., told a symposium on computing devices and rotating machinery that the computer was utilized before the electric drive and controls were installed on a large wind tunnel.

"Two factors made it desirable to examine the system on the computer," they said in a paper, "Analog Computer Study of Wind-Tunnel Drives." "One factor is the large power usage of the drive and the length of time involved in acceleration and deceleration at a rate acceptable to the electric utility. These considerations prohibited excessive tune-up adjustments and testing. The other factor is the transient current in the d-c machine during switching. It was necessary to determine that this current would not exceed breaker settings."

Nuclear Reactors. The Shippingport Nuclear Power Station near Pittsburgh, Pa., will have about the same load response and maneuverability as a conventional fossil-fuel plant operating on a utility system.

Such was the gist of a paper, "Load Control for the Shippingport Nuclear Power Reactor," presented by H. A. Van Wassen, of the Duquesne Light Company, Pittsburgh, who said, "The response of the nuclear heat source will not be a limiting factor for load changes which are beyond the design load limits of this plant."

The Shippingport Station, scheduled for completion this year, is the only full-scale electric power plant in the Five-Year Power Reactor Development Program proposed by the U. S. Atomic Energy Commission in February 1954.

Although the plant utilizes an unusual heat source—a nuclear reactor—the control of the output of the 100,000-kw generating unit will be similar to that of a conventional station. The initial capacity of Shippingport would be considerably lower than the 150,000 kw reserve capacity of the Duquesne Light Company's 1,207,000 kw system. Hence, loss of Shippingport due to forced outage would pose no very serious problem for the rest of the system.

Transmission and Distribution. The South Bend Division of the Indiana & Michigan Electric Company, a major operating company of the American Gas and Electric Company (AGE) system and the only one in the AGE system using 27.6-kv subtransmission, is being converted to 33-kv operation. The change followed an extensive economic study.

ABOVE: Dr. W. L. Everitt (center) is congratulated by W. J. Barrett (*right*), president of AIEE, upon receiving the AIEE Medal in Electrical Engineering Education during the general session of the Institute's Fall General Meeting. Looking on is R. W. Galvin (*left*), president of Motorola, Inc., who was the main speaker at the session. Right: President Barrett (*standing, left*) discusses meeting affairs with G. L. Welch (*standing, right*), general chairman of the Fall Meeting, and T. G. Ayers (*seated*), vice-president of Commonwealth Edison Company, who gave the address of welcome at the general session.

Two of six planned areas, at Hartford and Benton Harbor–St. Joseph, have already been converted, it was reported by three company engineers, H. K. Amchin, T. May, and T. J. Nagel in a technical paper, "Economics of System Conversion from 27.6-kv to 33-kv Operation."

Over a period of 33 years—the expected life of the new equipment—the accumulated 1957 present worth of the annual carrying charges on the investment was found to be $2,371,320. The corresponding total 1957 present worth of the savings was quoted at $2,592,531. Since the present worth of the savings is greater than the present worth of the costs, conversion may be regarded as economically feasible. However, since the figures are so close, other considerations had to be evaluated.

Metallic Rectifiers. Promising candidates for the rectifier material of the future were described by G. B. Kieh, physicist with the Fansteel Metallurgical Corp., North Chicago. These are aluminum antimonide (AlSb), gallium arsenide (GaAs), and indium phosphide (InP).

It was stated that these compounds offer fabrication difficulties, but they are not insurmountable, and their challenge has already been met with practical techniques. The promise of inherently better electrical characteristics and higher ambient temperature operation range of these compounds is, in fact, already being seriously tested in the case of GaAs.

At present, commercial rectifiers are fabricated from the familiar elemental semiconductors, selenium, germanium, and silicon, while special types have for 50 years been made from such compounds as silicon carbide and lead sulphide. Not until 1952 was it known that aluminum antimonide and indium antimonide are semiconductors and could be considered as rectifier material.

The three new rectifier "candidates" all possess melting points between silicon and germanium, while their energy gaps are higher than silicon, it was pointed out.

Communication Theory. A new system for the transmission of computer information called a "significant advancement in the communications art" was described by R. R. Mosier and R. G. Clabaugh of the Collins Radio Company, Burbank, Calif. The new system aids in answering a need at the present time greater than ever for more reliable and efficient forms of data communications.

The system, called "Kineplex," because it employs kinematic filters in its detection process and is most frequently employed in multiplex configurations, transmits computer information by wire or radio.

Power Generation. Extraordinary precautions are being taken against water leakage in the Experimental Boiling Water Reactor (EBWR) power plant at the Argonne National Laboratory near Chicago. Although the plant presently is using ordinary water, it is designed for ultimate utilization of expensive heavy water, necessitating that it be as leak proof as possible, three Allis-Chalmers Mfg. Co. engineers from Milwaukee, explained in a technical paper, "Special Features of 5,000-Kw EBWR Turbine Condenser and Pump." It was presented by C. H. Morris, K. H. Gruenwald, and C. E. Kenny.

The design out-leakage of heavy water for all equipment cannot exceed one pound per day and the in-leakage of atmospheric moisture is limited to one-half pound per day. This is extremely low when compared to a conventional plant leakage of approximately 1,000 pounds per day.

In a previously presented paper on the engineering design of the reactor, D. C. McClintock, of Sargent & Lundy, Chicago, had pointed out that heavy water costs in the neighborhood of $28 per pound, or about $233 a gallon; hence, extreme care must be taken to prevent its accidental loss.

Transformers. A preassembled enclosure for large power transformers which is believed will become an important means for achieving large reduction of sound level in very critical situations was described by M. W. Schulz and W. J. McNutt of the General Electric Company, Pittsfield, Mass. They emphasized that audible noise cannot be ignored in power-transformer installations if good community relations are to be maintained.

The main problem confronting the investigators of various types of enclosures over the past several years at General Electric's Pittsfield plant was the finding of a practical method for preserving the attenuating qualities of the enclosure and, at the same time, providing for an easy access of operation, inspection, and maintenance of the many accessories attached to the outside of the transformer tank.

In the design given final approval, the outer tank surrounds the main tank when completely assembled. The standard accessories are readily accessible from the outside of the enclosure. A sound-absorbing material is placed in the dead air space between the tanks to reduce the build-up of sound within the enclosure.

Communication Switching Systems. Mobile radio telephone service has developed to the point where dial service is now feasible. New dial equipment will be installed in a pilot system for the Rural Electrification Administration on the Florida Telephone Company's property at Branford, Fla. Later it will be transferred to the same company's exchange at Live Oak, Fla., reported R. P. Dimmer, of the Automatic Electric Company, Chicago, in a technical paper, "Automatic Mobile Telephone System."

He said that the equipment might serve rural areas in three ways: (1) by providing telephone service to isolated ranches, farm houses, and possible island locations in areas that cannot be served by wire lines, and known as fixed mobile service; (2) by providing mobile subscriber service where it is desired for farm, commercial or industrial use in automobiles, trucks, boats, and planes; and (3) by providing radio-telephone communications between the telephone office and its own mobile units for maintenance and operation.

Insulated Conductors. The expansion of many of the nation's large cities to include territory on both sides of bodies of water, has necessitated an increasing number of underwater tunnels being built for the transmission of power.

This report was made by E. J. Dawson of the Commonwealth Edison Company, Chicago, Ill.; R. W. Gillette of Consolidated Edison Company of New York, Inc., New York, N. Y.; and A. F. Corry of the Boston Edison Company, Boston, Mass.

The transmission of power through

Courtesy F. R. Danster

JOHN READ (left), General Electric Company, president of the Chicago Chapter of the Eta Kappa Nu greeting Dr. K. A. Strand, director of the Dearborn Observatory at Northwestern University, at the opening of the joint Eta Kappa Nu-AIEE luncheon during the Fall General Meeting of AIEE at the Morrison Hotel, Chicago, Ill., October 7. Dr. Strand was the principal speaker at the banquet. His subject was Exploration in Astronomy and the International Geophysical Year.

cable tunnels represents the largest investment cost as compared to the overhead tower crossing or to the submarine cable or bridge and viaduct types of crossings. However, this cost may be justified by several inherent advantages of tunnels and in locations where high-voltage overhead crossings are not permitted or desirable, or where a considerable number of large capacity lines are required to supply load requirements.

The three authors described the construction of such tunnels in Chicago, Boston, and New York. The last is of particular interest because in addition to high-voltage power cables, it contains gas, air, steam, and oil lines, and telephone trunk cables. The tunnel was originally constructed to house two 72-inch gas mains, with the other services being added, and proving that underwater tunnels can be employed for multiple purposes. The tunnel carries electric cables from the Consolidated Edison generating plant in Astoria to Manhattan under the East River.

Power Generation and System Engineering. The importance of determining, for reasons of maximum economy, the heating value of the fuel being used at each location in a power system was stressed by W. H. Guppy, of the Commonwealth Edison Company, Chicago, Ill., in a paper prepared for presentation at a session on Divided generation and system engineering. He emphasized that the primary purpose of any method of loading a power system is to produce power at the lowest possible cost and that the cost of incremental loading, the most widely accepted and least complicated method of achieving economy, is a direct function of fuel heating value.

"At any instant," he said, "fuel heating value probably is unknown, so that incremental fuel cost and, consequently incremental loading cost, is in error. However, over a long period, reasonable accuracy can be expected."

Incremental cost is generally the product of three separate items: the cost of fuel, the quantity of heat required to change output of a turbogenerator unit, and the transmission loss to the point of load demand.

Computing Devices. With the advent of high-speed powerful data-processing facilities, the "Age of Clerical Revolution" in "white-collar" business areas is at hand, stated C. A. R. Kagan of the Western Electric Company, New York, N. Y., in a paper prepared for presentation before a session on computing devices. He said that the clerical "revolution" is near although to date clerical automation has not kept pace with manufacturing automation.

The use of high-speed information processing through computers is the solution for handling information at a pace equal to the development of manufacturing methods and industrial growth.

Automatic computation in business is necessary to assist management in rendering sound and economical judgments without the handicap of information delays which tend to make their rulings out of date and possibly invalid.

When it comes to translating a foreign language such as Russian, by a computer, the electronic "brain" can remember only about one millionth as much as the human brain. This is one of the reasons why machine translation at present should be done on a word-for-word basis, said R. E. Wall, Jr., and U. K. Niehause, of the University of Washington, Seattle, in a paper, "Russian-to-English Machine Translation with Simple Logical Processing." Another difficulty in machine translation is the limitation in our present language knowledge.

A skilled polyglot accomplishes translation from one language to another by translating thoughts; the source language material is read and digested, and then the thought of the material is formed into target language sentences and recorded. The unskilled translator would translate first on a word-for-word basis, and then make improvements in the output by consideration of the context of the words. The ultimate in machine translation would be that of translation by thought as the accomplished polyglot would translate, but several fundamental problems remain to be solved before anything of this sort may be accomplished. For instance, there is a great spread between the amount of storage in the human brain and the greatest amount of storage available in any present-day computer.

The brain is estimated to have a total storage capacity of 10^{15} to 10^{20} bits. The largest of computers will store only about 10^{9} bits, or not over one-millionth as much storage as the human brain. A second limitation is that of our present knowledge of language. Linguistic knowledge concerning many problems which are vital to machine translation is rather lacking. Thus, it would seem that in the present elementary state of the machine translation art, we should attempt to perform our translations more as the unskilled translator—by basing our translations on the word-for-word translation, making such improvements as we can from a consideration of the context of the words in the sentence.

Electronics Transformers. Experience has shown that the use of improved cooling or high-temperature insulation allowing for higher heat density can result in the size reduction of airborne transformers by more than one half. This was the report of R. E. Lee, Westinghouse Corp., Baltimore, Md. Result of using better cooling or high-temperature insulation will be lighter airborne electronic equipment with no sacrifice in performance or ability.

High temperature insulation will let the transformer run hot. If the channels for heat flow are not improved, the temperature rises until heat flow due to the temperature is not primarily the result of more heat, but the same heat in a smaller space; therefore, the ultimate heat sink is not increased significantly. The problem is getting the heat to that sink. The other method of heat removal is to provide for a better heat conducting path between the heat source in the transformer and the ultimate heat sink.

"Perhaps the best design for many applications," Mr. Lee said, "is a combination of these two heat removal methods. Thermal conductors built into the transformer can greatly improve the heat flow and, therefore, reduce the temperature rise in the transformer. Circulating or evaporating fluids are other very effective ways to obtain increased heat flow from the transformer."

Wire Communications. Field tests have proved a new telephone subscriber carrier system to be the answer to the need for a high-quality, easily maintained carrier system for rural subscriber lines. R. L. Layburn of the Stromberg-Carlson Company, Rochester, N. Y., reported that the new system, known as *56I Carrier*, shows a high degree of reliability with no component failures of any kind during several months of field operation. Several severe thunderstorms occurred during the trials, but no transistor or other component failures resulted.

Industrial Control. A photoelectric device consisting of a radioisotope source, photoconductive crystal detector, and transistor output circuitry and offering the advantages of small size, low cost, and maintenance-free reliability was described in a paper by Paul Weisman and S. L. Ruby of the Westinghouse Electric Corp., Pittsburgh, Pa.

"The combination of radioisotope source, cadmium sulphide radiation detector, and transistor amplifier constitutes a completely solid-state photo-electric system," the authors stated. "It combines much of the versatility of photoelectric control with the reliability of solid-state components. In applications where reliability is most critical, where the equipment is inaccessible for maintenance, the device has its greatest advantage."

The unit was developed to overcome a weak link—the light source—in the development of solid-state photoelectric limit switches, hot metal detectors, and other kinds of position indicators made possible through the availability of solid-state light detectors. A tungsten-filament lamp, it was pointed out, consisting of a thin wire in a glass-enclosed low-pressure atmosphere requiring a power supply to heat that thin wire to incandescence, is neither rugged nor reliable. In addition, constant maintenance may be necessary to keep the light beam from being obscured in dusty or smoky environments.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus and Systems,* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Functions of Technical Committees and Operational Procedures Discussed at Forum

THE FORUM of Technical Committee Chairmen held in Chicago, Ill., on October 3, 1957, was educational in nature as is customary for the first meeting in the administrative year. Hendley Blackmon, chairman of the Technical Operations Department, conducted a panel comprised of the six Technical Division chairmen, each of whom presented an important aspect of committee procedure. The sights for the meeting were set by President W. J. Barrett, the first speaker, who outlined in five points the functions of technical committees and the aids to the accomplishment of objectives as follows:

Functions of Technical Committee

1. The Technical Committee should be the ultimate engineering authority on the subjects within its scope. It should take responsibility for initiating and developing engineering standards in its field.

2. The Technical Committee should be alert to the newest engineering developments and scientific discoveries in its field, and diligent in its efforts to bring these to the membership of the Institute in the most authoritative and complete form possible.

3. The Technical Committee should not wait passively for the development of new engineering information but where a need is recognized the Committee should undertake to stimulate necessary research to obtain information for the solution of problems in its field. In this connection, it should bear in mind the facilities which are available through Engineering Foundation for assistance in research.

4. The Technical Committee should prepare reports from time to time on the progress of the art and science in its field. These reports would involve evaluation and selection rather than merely summarize events or describe commercially available products. The reports should not merely recite the operational functions of the Committee or list its meetings and activities.

5. At intervals, the Technical Committee should publish a review of the state of the art, tracing its progress since the beginning so as to inform the membership, including Student members, with respect to this progress and its significance. Engineering text book writers of the future should lean heavily on the publications of AIEE for authoritative information. Their bibliographies should, of necessity, be heavily weighted with reference to Institute publications.

Aids to Accomplishment of Objectives

1. Personnel of the Committee must include those who have mastery of the subject matter and authority in the field.

2. The Committee shall include broad representation so that a maximum number of points of view shall be brought to bear. The members must be willing to devote the time necessary.

3. New Technical Committees and Subcommittees to deal with newly opened fields should be established promptly, and without limit, as the art progresses and diversifies.

4. Keeping the membership informed on progress in the technology involves more than publication or reading and discussion of papers at large meetings. What is needed is individual participation by as many members as possible in the technical activities of the Institute in the Sections and Subsections. The formation of technical groups within these geographical subdivisions must be stimulated and these groups must be tied effectively into the Institute's Technical Committee structure. This will be of benefit in both directions. The Technical Committee can furnish valuable information to the local groups to assist in their activities. The local groups can be called upon to consider and comment on proposed standards and papers. The local groups will provide a source of personnel for the Technical Committee.

5. Special Technical Conferences have proved very successful and worthwhile. More of these conferences should be held under the sole auspices of the Institute. Technical Committees of the AIEE should promptly take the initiative in new fields. In too many cases, the Institute seems to be following the leadership of younger organizations. Every effort should be made to see that those who attend joint conferences should be made fully aware of the Institute's accomplishments in the field. One helpful procedure in this connection would be to print and distribute at all conferences and exhibitions, summaries of the appropriate Technical Committee's activities and publications in the field. There should be a clearly defined policy covering the basis upon which the Institute will co-operate with other organizations in the sponsorship of Special Technical Conferences.

Manpower Development

With a view toward developing a successor and expanding committee work, Hendley Blackmon stressed that each committee chairman should survey his present manpower and cultivate leadership for four to five years hence. The start of systematic manpower development as a primary objective was advocated and it was suggested that this could be done by loading up the vice-chairman. In this way, two committee officers would know the procedures in event of an emergency and the chairman would be relieved to do more creative thinking and long-range planning for the maximum strengthening of his committee.

Recommending Committee Memberships

The factors to take into consideration when recommending people to serve on committees and subcommittees were outlined by H. F. Hoebel, chairman of the General Applications Division Committee. The all-important factor is the ability and willingness to serve actively. Mr. Hoebel stressed that the chairmen should especially note the activity and interest of all members: interest in the committee's work, attendance at meetings, and participation in the discussions in person or through correspondence. Among the other factors brought to focus was the need for geographical and company balance as well as the advantages of adding more young engineers to the technical committees. Geographical balance has been improved in recent years with general acceptance of air travel. The local Sections could be of assistance by recommending through established channels competent young engineers to serve on committees.

Handling and Programming Papers

The handling of the several kinds of papers for presentation at General and District Meetings was described by E. I. Pollard, chairman of the Power Division. Among the many points considered, the speaker explained that the quality of papers and sessions rested squarely on the critical attitude of the reviewers. He stated that the chairmen of the technical committees should become familiar with the type of engineering work done by each member of their committees as well as their background and technical skills with a view toward fitting the reviewers to the type of paper under consideration. After a paper has been revised in accordance with suggestions of reviewers it should be returned to the same reviewer rather than a different group. When soliciting papers, timely subject matter should be obtained from authors competent to write on the subject chosen for the sessions.

Special Technical Conferences

The procedure for organizing and handling Special Technical Conferences was outlined by J. G. Reid, Jr., chairman of the Science and Electronics Division Committee. As these conferences are somewhat newer, a higher degree of flexibility is obtained which permits concentration on more or less specialized fields and new fields in the fringe areas. The Technical Operations Department has appointed a Special Technical Conference Subcommittee, which has a member from each of the Technical Division Committees. Mr. Reid suggested that each Division should review what conferences have been held recently and determine which conferences should be held in the future. In regard to the details of operation and organization, the Institute has a statement, "Policy and Procedure in Organizing Special Technical Conferences," which can and should be obtained from R. S. Gardner, assistant secretary, Technical Committee Activities, at AIEE Headquarters.

In conclusion, Mr. Reid stated that 27 to 28 Special Technical Conferences are held per year with an average attendance of 550 persons and presentation of 28 papers per conference. Publication requirements recently have been more simplified permitting more rapid conversion to Transactions papers. It also was stated that such types of conferences have been equally popular in other societies.

Conducting Committee Meetings and Sessions

To conduct committee meetings, John Meszar, chairman of the Communication Division Committee, called attention to one point: namely, a chairman must exercise all his skill and ability at the committee meetings in order to achieve full participation by the members in the discussions and the decisions of the committee. A good chairman does not control or boss or drive his committee but creates an atmosphere for perfect freedom of discussion and thus stimulates every member to participate and to contribute. This brings into play the highly effective power of group thinking and group motivation.

With respect to presiding at a session, Mr. Meszar advised that the presiding officer should be sure to obtain the pamphlet, "Technical Sessions Guide," from AIEE Headquarters and he advised that presiding officers should follow carefully the practice and helpful suggestions in the guide, which is the distilled wisdom of predecessors who have put much thoughtful effort into it.

Necessity of Observing Deadline Dates

In a well illustrated talk, "Deadlines—Run Them or They'll Run You," C. F. Savage, chairman of the Instrumentation Division Committee, explained how these deadline dates are determined and the chaos that results when such dates are missed or not observed. He explained that there are two different kinds of deadlines—those set internally in the Institute and those determined externally to the Institute. The latter is determined by the availability of printing equipment, business competition, and costs. As to sources of information, the AIEE timetable is found on the inside cover of the "AIEE Organization Manual" and the AIEE future meeting schedule is published each month in *Electrical Engineering*. For example, see page 896 in *Electrical Engineering* for October 1957.

The importance of deadlines was emphasized as an integrating function involving co-operative efforts of many people welded into a united effort toward common objectives. Missed deadlines cost money, result in poor quality, lower efficiency, and irretrievable loss of time.

Forecasts of Sessions and Papers

The purpose, periods to be covered, and forms to be used by technical committees for forecasting the number of different kinds of papers and sessions were outlined by C. N. Clark, chairman of the Industry Division Committee. Forecasts are made twice a year to cover a period of approximately 18 months. After the data is received from each technical committee, a consolidated forecast is made by the Division and then a general summary is compiled by the entire Technical Operations Department. This information is very valuable as an indication of the relative amount of technical activities to be undertaken by the various committees and Divisions. The forecast is also needed by the Publications Department to make a reasonable estimate of the financial requirements for each year's budget to cover the cost of the printing of Transactions papers, conference papers, preprints, and Special Technical Conference proceedings. The staff also uses the forecasts in working out a preliminary schedule of sessions.

Forecasts and planning ahead give the best possible service to members, and technical committees also benefit by planning further ahead because their members will be informed sooner about future programs. They also aid in providing better continuity when the chairman of the technical committee is succeeded by the vice-chairman.

After the panel presentations, the meeting was open for discussion which had to do mainly with the methods employed when recommending members for committee appointments and the task of appointing them. Questions were answered by members of the panel, Hendley Blackmon, and the Secretary.

Board of Directors Meeting Held October 11, 1957, in Chicago

THE AIEE BOARD OF DIRECTORS held its customary Fall meeting during the 1957 AIEE Fall General Meeting in Chicago, Ill., on October 11, 1957. Present at the meeting were 25 members and 5 Department Chairmen. W. J. Barrett, president of AIEE, was in the chair.

Finances

L. F. Hickernell, treasurer, reported a cash balance in the General Fund of $372,137.56 and a "book value" of the Reserve Capitol Fund of $1,125,876.94. Expenditures for June through September 1957 totaled $803,300.38 including $195,000 transferred to the Reserve Capitol Fund as part of a loan to United Engineering Trustees for the purpose of acquiring a site for the new United Engineering Center.

C. H. Linder, chairman of the Finance Committee, presented routine budget amendments for Student Branch activities and the conversion of office equipment and procedures. He reported that the Finance Committee is proceeding to modernize and simplify many of the Institute business and financial methods currently carried out in accordance with Constitutional requirements which are also under review. Future budgets of the Institute will be made on a departmental basis rather than by committees. Income and expenses to date would appear to indicate a favorable balance at the end of the fiscal year April 30, 1958.

Nominating Committee

The Board of Directors elected its quota of 6 representatives to the Institute Nominating Committee to meet along with the 6 representatives from the Technical Divisions and the 12 representatives from the Districts, on February 2, 1958, in New York, N. Y., to select the candidates for the Institute offices in 1958-1959. The Board's representatives will be W. R. Brownlee of Birmingham, Ala.; M. S. Coover of Ames, Iowa; J. H. Foote of Jackson, Mich.; M. D. Hooven of Newark, N. J.; L. M. Robertson of Denver, Colo.; and J. C. Strasbourger of Cleveland, Ohio. Three alternates were selected: W. R. Clark of Philadelphia, Pa.; A. A. Johnson of Pittsburgh, Pa.; and P. G. Wallace of Dallas, Texas.

Fellows

Sixteen members of the Institute were elected to the grade of Fellow. Their biographies and pictures will appear in a later issue of *Electrical Engineering*. Those elected were E. H. Anson; G. W. Bean; R. S. Cannon; C. F. Dalziel; E. N. Dingley; Alois Hoefle; P. M. Honnell; W. M. Joslin; D. D. Knowles; D. E. Marshall; John Maxian; A. J. Petzinger; R. V. Shepherd; H. D. Snively; Carlton Steiner; and G. C. Tenney.

Intersociety Affairs

The Board received reports that its plan for the clear assignment of intersociety activities, among the federations and general engineering organizations now striving to represent the profession in various ways, has been misunderstood and misrepresented. It was decided to review what has come to be called the "San Francisco Policy" as expressed in the President's letter published in *Electrical Engineering*, June 1957, page 516.

The results of this review are best stated by the actions taken at this Board meeting:

"VOTED that it is the interpretation of this Board that the action of the Board of Directors at San Francisco (June 28, 1956) did not propose that AIEE relinquish any of its interests and activities," and

"VOTED that AIEE continue its traditional support of the activities of EJC and ECPD with full recognition, on everyone's part, that AIEE is aiming toward the objectives established at San Francisco."

United Engineering Center

The President outlined plans for the campaigns for the United Engineering Center Building Fund among industry and the membership of the interested societies. The Board authorized the appointment of an AIEE member gifts campaign committee. The Executive and Finance Committees were authorized to make commitments for space in the proposed new building.

NSF Board Nominations

AIEE has joined with other societies of Engineers Joint Council (EJC) to recommend to President Eisenhower the appointment of T. K. Glennan, M. P. O'Brien, and General L. E. Simon to the

National Science Foundation Board (NSF).

AIEE members also were nominated for the various committee posts in Engineers' Council for Professional Development (ECPD). These committees were to be announced by ECPD after its Annual Meeting of the Council on October 25, 1957.

AIEE Constitution and Bylaws

Constitution and Bylaw amendments were approved to the following effects:

(1) Bylaw amendments will hereafter become effective August 1 unless otherwise ordered by the Board in which case a special announcement in *Electrical Engineering* will be required.

(2) The Professional Development and Recognition Department will have responsibility for all rules and regulations governing medals and awards and will include among its membership the Volta Scholarship Trustees.

(3) A candidate for Fellow (if the membership approves amendment of C4) need not be presently actively engaged in the electrical field. He may be retired. A similar change is provided for Member candidates in a revised C5.

(4) The Board of Examiners will decide on adequacy of the number and quality of replies received from references supplied by applicants.

(5) The Technical Divisions may permit the publication of papers prior to presentation, or without presentation.

The Constitution and Bylaws Committee (C&B) will provide the Board with a report on the basis of which to choose whether to present to the membership, for approval in the Spring of 1958, a restyled Constitution in a new format with little change in context or at some future date, a completely rewritten Constitution, Bylaws, and Operating Rules. The first job, well started by E. S. Lammers, is now nearing completion by R. E. Kistler, the current chairman of the C&B Committee. The second proposal is estimated to require several years to carry out.

Future Board Meetings

The Board set the following dates and places for its future meetings: February 7, 1958, in New York, N. Y.; April 30, 1958, in Washington, D.C.; June 27, 1958, in Buffalo, N. Y.

An invitation was received from the Sacramento Section to hold a Board meeting during the 1958 AIEE Pacific General Meeting, August 19-22, 1958.

The 1958 Annual Meeting of the Institute was set for June 23, 1958—the first day of the 1958 AIEE Summer General Meeting in Buffalo, N. Y.

The Electrical Historical Foundation

Past-President M. D. Hooven was appointed to represent AIEE on the Board of Directors of the Electrical Historical Foundation. The purpose of the Foundation is to locate, preserve, and encourage the public display of historical electrical equipment, photographs, printed matter, etc., and to promote an interest in, and appreciation of, electrical engineering. Other officers of the Foundation are Fischer Black, chairman, Julian Sprague, Bern Dibner, E. S. Lincoln, and S. G. Hibben.

New District No. 13 Authorized

Subject to final approval of the wording of Bylaws at its February 1958 meeting, the Board approved the creation, as of August 1, 1958, of a new "South Central District" No. 13—the western half of the present District No. 4. The eastern half will continue as District No. 4 "The South East District." Special arrangements were approved for carrying on joint activities between the two Districts until certain commitments are concluded.

The 75th Anniversary

The President was authorized to appoint a committee to plan for the suitable celebration of the 75th Anniversary, in 1959, of the founding of AIEE.

Resolutions of commendation and appreciation were addressed to the 1957 AIEE Fall General Meeting Committee and the officers and members of the Chicago Section.

New United Engineering Center To Be Erected on United Nations Plaza

THE NEW United Engineering Center will be erected on United Nations Plaza between 47th and 48th Streets in New York City.

Designed to symbolize the dignity and achievements of the engineering profession, the Center will provide national headquarters for the continued advancement of engineering and technology. Not only will adequate facilities be provided for performing present functions, but sufficient provision will be made to include continuing growth of services to the engineering profession.

A 20-story tower surrounded by lower structures with landscaped surroundings, the new Center will offer almost three times the usable space in the present Engineering Societies' Building. In addition to space requirements of the Societies, rooms for engineering meetings and committee activity will be provided. Private dining rooms for engineers attending meetings are planned, as well as a cafeteria.

Enlarged library and publication facilities are included in plans for the new Center. An exhibition space is planned in which the rapid advances in engineering will be interpreted for the general public. In keeping with the traditions and dignity of a proud profession, a memorial hall is planned to perpetuate the contributions of great engineers to the effectiveness of American civilization.

Like any well-engineered project, the Center will permit expansion for all foreseeable needs for the next half-century, will be attractive without being ornate, and will embody dignity without implying pretension.

The new Center will represent the culmination of plans on the part of United Engineering Trustees, Inc., and the five Founder Societies, which date back to the Fall of 1955 when a Task Committee

ARTIST'S RENDERING of the new United Engineering Center to be erected on United Nations Plaza between 47th and 48th Streets in New York City. Architects for the new building are Shreve, Lamb & Harmon Associates.

of 13–3 from each Society—was appointed. This Committee had its first meeting on October 10, 1955, and on June 22, 1956, submitted the following recommendations.

"Item 1—The Engineering Societies' Center be located in New York City.

"Item 2—The 39th-40th Street site be continued in use as the site of the Engineering Societies' Center.

"If rebuilding in that area proves impracticable, a comparable site should then be sought in midtown New York."

Approval of the recommendations was completed by the end of November 1956 and the firm of Shreve, Lamb & Harmon Associates was retained to assist in determining the feasibility of developing the present building site. After thorough study, the Trustees decided on February 12, 1957, to abandon plans for the present site and to seek a new one.

On August 1, 1957, the acquisition of a site on United Nations Plaza between 47th and 48th Streets in New York City, was announced. The firm of Shreve, Lamb & Harmon Associates was retained as architects.

Symposium on Reliability and Quality Control, January 6-8, 1958

Sponsored by the AIEE, Institute of Radio Engineers (IRE), the American Society for Quality Control (ASQC), and Electronic Industries Association, the 4th National Symposium on Reliability and Quality Control will be held January 6-8, 1958, at the Hotel Statler in Washington, D. C.

The keynote speaker for the symposium will be Maj. Gen. F. L. Ankenbrandt, USAF (Ret.), defense electronic products, Radio Corporation of America.

At the banquet on Tuesday, January 7, at 7 p.m., L. N. Hyland, vice-president and general manager of Hughes Aircraft Company, will deliver the major address, "The Challenge of Reliability to Management." At the same time, the National Reliability Award will be presented by M. M. Tall; the IRE Professional Group on Reliability and Quality Control (PGRQC) Award will be presented by Dr. Victor Wouk, chairman of the PGRQC; and the ASQC Electronics Division Award will be presented by I. W. Schoeninger.

During the three-day symposium, there will be nine tours—one to the Naval Ordnance Laboratory every morning at 8 a.m.; one to the Potomac Railroad yard at Alexandria, Va., each morning at 8 a.m.; and one to the NBC radio and television station, also at 8 a.m. each morning.

The tentative technical program for the symposium follows.

Monday, January 6

10:00 a.m. Morning Session

Ageing Effects in Transistors. *Dr. R. M. Ryder*, Bell Telephone Company

Simplified Reliability Evaluation. *C. M. Ryerson*, Radio Corporation of America

Deterioration and Failure as a Stochastic Process. *M. L. Norden*, New York University

The Effects of Maintenance on Part Reliability. *R. L. Madison*, Aeronautical Radio Inc.

Current Military Reliability Specifications. *D. W. Pertschuk*, American Bosch Arma Corp.

Military Reports on Reliability. *T. M. Child*, U.S. Army; *J. L. Miller*, U.S. Navy; *Lt. Col. J. S. Lambert*, U.S.A.F.

2:00 p.m. Afternoon Session

Mathematics and Statistics Used in Reliability. *N. A. Woodbury*, New York University

Reliable System Design by Part Engineering. *G. G. Walance*, Hughes Aircraft Company

Systematic Methods in Missile Seeker System Design. *H. V. Cooper*, Bendix Aviation Corp.

Reliable Design and Development Techniques. *J. E. McGregor*, International Business Machines Corporation

Panel on System Reliability Measurement. *G. M. Armour*, General Electric Company, moderator

7:30 p.m. Panel Discussion

Reliability Definitions Panel—Open Discussion *C. M. Ryerson*, Radio Corporation of America, moderator

Tuesday, January 7

9:00 a.m. Morning Session

Accelerated Life Test in Airframe Manufacture. *Dr. M. H. Simpson*, General Dynamics Corporation

Accelerated Life Testing To Predict Failure Rate. *B. Hecht*, Sprague Electric Company

Study of Accelerated Life Test vs Field Operation. *Joseph Kimmel*, Radio Corporation of America

Accelerated Light Test of Precision Resistors. *H. S. Herrick*, Erie Resistor Company

Mechanical Airline Equipment Reliability Analysis. *A. M. Hull*, United Airlines, Inc.

Improved Reliability by Stabilizing the Transistor. *O. R. Baker*, International Business Machines Corporation

Some Reliability Factors of Electrical Insulation. *N. M. Bashara*, University of Nebraska

Large Digital Computer Dependability Measurements. *G. B. McCarter*, International Business Machines Corporation

2:00 p.m. Afternoon Session

Reliability vs Cost of Failure. *G. A. Raymond*, Remington Rand

The Price of Reliability. *A. L. Lambert*, The Martin Company

Significances of R & D—Reliability and Dollars. *Dr. E. T. Welmers*, Bell Aircraft Corporation

Reliability Costs for Spares at Remote Locations. *Dr. R. J. Herman*, Bell Telephone Laboratories

Report on Northrop's Tube Surveillance Program. *Dwight Hawley*, Northrop Aircraft Company

Design and Analysis of Comparison Tests on Parts. *R. P. Bosley*, American Bosch Arma Corporation

Evaluating Component Parts by the Box Technique. *R. Glaser*, General Electric Company

The Mechanisms of Failure of Tantalum Capacitors. *Dr. M. E. Krasnow*, Inland Testing Laboratory

Wednesday, January 8

9:00 a.m. Morning Session

Reason—Reliability and Reality. *L. J. Jacobson*, Electronic Industries Association

Vendor Certification Program. *D. A. Hill*, Hughes Aircraft Corporation

Test Program Design for a Missile Guidance System. *R. P. Grant*, American Bosch Arma Corporation

Commercial Aspects of Guaranteed Reliability. *W. A. MacCrehan*, Bendix Radio Company

Organization for Reliability. *H. Knapp*, Federal Telephone and Radio

TALOS Missile Data System Contributes to Management. *R. R. Wendt*, Bendix Aviation Corporation

Chase Ltd., Photo

SOME OFFICERS serving on the Managing Committee for the 4th National Symposium on Reliability and Quality Control are: (*left to right*) I. W. Schoeninger, vice general chairman, Centralab Div., Globe Union; M. P. Smith, registration chairman, Minneapolis-Honeywell Regulator Company; M. M. Tall, general chairman, Radio Corporation of America; J. Kaufman, arrangements chairman, U. S. Army; J. W. Greer, vice general chairman, U. S. Navy; and P. K. McElroy, transactions chairman, General Radio Company.

Organizing Reliability in Airborne Equipment Manufacture. *J. J. Crowley*, General Dynamics Corporation

Organizing for Reliability at Westinghouse. *Trevor Clark*, Westinghouse Electric Corporation

2:00 p.m. Afternoon Session

Techniques and Relationships of Quality Control and Reliability. *J. J. Riordan*, Office of Secretary of Defense

Controls for Reliability and Quality Assurance. *H. G. Romig*, Summers Gyroscope Company

Propagation of Error Techniques in Electronic Circuits. *M. Racite*, International Business Machines Corporation

Vendor and Subcontractor Liaison for High Reliability. *J. A. Rice*, American Bosch Arma Corporation

TALOS Reliability and Quality Education Program. *W. H. Johnson*, Bendix Aviation Corporation

Education and Engineering Reliability. *Dr. A. B. Credle*, International Business Machines Corporation

Training Evaluation Engineers for Reliability Programs. *Dr. L. W. Ball*, Stellardyne Laboratory

Training Through Design Reviews. *H. G. Bryson, Jr.*, Radio Corporation of America

Additional Conference Papers Are Now Available

The following is a list of conference papers presented at the 1957 AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, which were not numbered at the time of the meeting. They have now been numbered and are available to members for 40¢ and to nonmembers for 80¢. Send order and remittance to: AIEE Order Department, 33 West 39 St., New York 18, N.Y.

CP57-1103 The Growing Importance of Ethics to Engineers. *P. L. Alger*

CP57-1104 Mechanization of Toll Switching in Providence, R.I. *C. W. Anderson*

1105 Improved Safety in the Control of Stamping Presses. *T. N. Anderson*

1107 Wired Vision and Pushbutton Control. *E. A. Berry*

1108 The Systems Approach to the Determination of Television Coverage. *R. M. Bowie*

1109 Electric Snowmelter Systems for Railroad Track Switches. *D. R. Brewer*

1114 Major Design Concept of the Instrumentation for the Country's First Privately Financed Atomic Power. *E. P. Diehl*

1116 Switching Transients in Small Motors. *R. K. Drake, S. A. Zimmermann*

1117 Testing the Adequacy of Industrial Power Distribution Systems. *A. Durand, D. Dalasta*

1118 Bridge Method for Pulse Measurements on Miniature Core Materials. *A. D. Furbee*

1120 Sequence Control of Mining Belt Conveyors. *Ben Harbage*

1122 The Measurement of Television Field Intensities and the Relationship between Field Intensity and Picture Quality. *H. T. Head*

1123 Design Considerations for Dry-Type High-Voltage Power Supplies for Electrostatic Processes. *E. C. Hill*

1124 Argonne Low-Power Reactor Instrumentation Design. *H. H. Hooker*

1126 Electrical Problems Involved in Designing Fluorescent Mine Lighting Systems. *R. S. James*

1128 400-Cycle Electrical Distribution Systems for Power or Lighting. *D. L. Johnson*

1129 Radio Multiplex with Circulators. *L. B. Johnson*

1131 Preparation of Silicon Carbide, Single Crystal and Use in Rectifiers. *L. Kroko, H. Chang*

1133 Factors Affecting Rating of Mine Motors. *L. L. Lipanye*

1136 Current Carrying Capacity of Portable Cables on Reels. *J. McNiff, A. H. Shepherd*

1137 Summary of Performance of UHF and VHF Television Transmitting and Receiving Equipment. *W. J. Morlock, W. O. Swinyard*

1140 Reliability of Instruments Power Supply for Reactors. *J. Parnell, C. W. Sundin*

Courtesy Franklin Foto Studio

AT THE SPEAKER'S TABLE during a Michigan Section Meeting are: (left to right) W. R. Carlyon, chairman of Program Committee; R. L. Calkins, affiliate activities group advisor; C. R. Siebert, Section director; B. H. Schneider, Section vice-chairman; J. S. Kirkpatrick, main speaker, vice-president in charge of research and development, Brooks and Perkins, Inc., Detroit; J. E. Beach, vice-chairman of Program Committee and in charge of program for this meeting; and Frederick Von Voigtlander, Section junior past chairman.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

CP57-1141 Prediction and Measurement of the Coverage of a Television Station. *D. W. Peterson*

1142 Determination of Incremental Heat Rate Characteristics from Operating Records. *V. R. Peterson, A. H. Willennar*

1145 Rapid Spot Test Methods for the Evaluation of Used Transformer Oil. *R. E. Reinhard, W. E. Elliott*

1146 Standard Basic Impulse Insulation Levels. Report by AIEE Standards Co-ordinating Committee #8

1148 Switching Voltages of Induction Motors. *E. C. Schrom*

1151 A Theory for Shaded-Pole Motors. *F. W. Suhr*

1152 Standardization of Cables and Hose Conduits of Mine Motors and Controllers. *J. Tindall*

1153 The Television Allocations Study Organization—Its Origin, Objectives, and Progress. *G. R. Town*

1155 Electric Locomotives for the Butte, Anaconda and Pacific Railway. *W. Wishart*

1158 Supply to Large Shopping Areas in the Chicago Metropolitan Area. *W. R. Zimmermann*

Satellite Discussed at Michigan Section Meeting

More than 200 members and guests of the Michigan Section of the AIEE heard an authority on space satellite construction and honored a past chairman at a dinner meeting held October 8, in the Hotel Hayes at Jackson, Mich.

J. S. Kirkpatrick, vice-president for research and development for Brooks and Perkins, Inc., of Detroit, which is manufacturing the outer shell for the satellite the United States plans to launch, said that regardless of whether the USSR cooperates, the West can expect to gain important information from satellite "Sputnik." He added that "even if we cannot monitor the radio signals being beamed from the satellite we stand to gain much from studying its course. We can expect to learn a great deal about the mass distribution of the earth and the density of the atmosphere. We will gain knowledge that up to now has been inaccessible to us."

Mr. Kirkpatrick said that no one should minimize the importance of the Soviets' accomplishment and predicted that it will rank with the printing press and other great inventions as one of the major turning points in the history of man.

He noted that the Soviet satellite reportedly weighs 185 pounds, and if so the Russians must have some very beautiful rocket engines.

During the meeting, Frederick Von Voigtlander was awarded a past chairman pin in recognition of his services last year as chairman of the Michigan Section. The presentation was made by Burke Schneider, Section vice-chairman.

Responsible for the success of the meeting were J. E. Beach of Commonwealth Associates, Inc., who introduced the speaker and was in charge of the program for the meeting; C. J. Meyer of Consumers Power Co., in charge of entertainment; and G. W. Grueneberg of Consumers Power Co., in charge of the Contact Committee.

Los Angeles Section Holds Impressive General Meeting

Harry Lott, chairman of the Los Angeles Section, with over 2,500 members, on October 8 opened the 1957-58 year with a general dinner meeting which presented a nationally known speaker and honored five section members for national activity with the Institute.

Dr. G. D. McCann, professor of electrical engineering, California Institute of Technology, gave a very comprehensive talk on the scope and depth of electrical engineering education of today. He stressed the need of creative engineering in the basic sciences and the many fields of specialization. He discussed several important and dramatic examples of the challenges to today's electrical engineer and created a very timely interest by comparing the USSR's scientific education with the training received in this country. These comparisons indicated that the USSR is graduating nearly twice as many engineers and scientists with training equal to ours.

The meeting honored five members of the Los Angeles Section who received the Institute's Certificate of Recognition and Appreciation for their contributions as a national or Section officer. The men so honored were Bradley Cozzens, vice-president, AIEE District No. 8; A. M. Zarem, Technical Committee chairman, National Electronics Committee; P. L. Savage, chairman of the Los Angeles Section 1956-57; F. L. Long, Jr., chairman Boulder City Subsection 1956-57; K. V. Fletcher, chairman, Riverside-San Bernardino Subsection 1956-57.

T. M. Blakeslee, chairman of the Transfers Committee, presented A. P. Hill with a diploma making him a Fellow of the Institute and a member of the Royal W. Sorensen Fellows of Los Angeles. Mr. Hill has been an active member of AIEE since 1923, and is a past chairman of the Los Angeles Section.

LOS ANGELES SECTION MEMBERS recognized for their services to the AIEE are: (*left to right*) Harry Lott, A. M. Zarem, P. L. Savage, A. P. Hill, T. M. Blakeslee, K. V. Fletcher.

Over 400 Engineers Attend Magnetic Amplifiers Conference

The second Special Technical Conference on Magnetic Amplifiers was held on September 4-6, 1957, at the Penn-Sheraton Hotel in Pittsburgh, Pa. Over 400 engineers attended technical sessions and viewed exhibits at the three-day conference.

The conference was sponsored by the AIEE Magnetic Amplifiers Committee with the participation of the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics. During the conference, 20 technical papers were presented, including a talk by W. J. Barrett, president of the AIEE, on "Institute Policy and Organization of the Engineering Profession." Highlights of the conference included papers by Dr. L. A. Finzi, of Carnegie Institute of Technology, on methods of training engineers in the field of magnetic devices, and a paper by Dr. H. F. Storm of the General Electric Company on special applications of nonlinear magnetic materials. Topics presented during the sessions included instrument applications, new techniques in the design of polyphase magnetic amplifiers, and a unified approach to magnetic amplifier design.

Of particular interest were the evening sessions organized to provide an opportunity for informal discussions of the papers and the theory and applications of magnetic amplifiers. Approximately 130 persons attended two sessions devoted to theory and applications from 8:00 to 11:30 p.m. on the second night of the conference. Subjects discussed included new theoretical treatments in connection with triggering and magnetic material behavior. Also discussed were reliability concepts in commercial and military equipment and the future needs for operation of magnetic amplifiers at temperatures up to 600 C. A lively discussion was held on the necessity for more reliable semiconductors for use with magnetic amplifiers.

Owing to the success of the first two conferences on magnetic amplifiers, plans are now essentially complete for the third Special Technical Conference which will be held in Los Angeles, Calif., at the Hotel Statler, August 5-8, 1958.

MEMBERS of various Magnetic Amplifiers Conference Committees shown with AIEE President W. J. Barrett are: (*front row, left to right*) R. A. Ramey; R. W. Roberts; B. R. Teare; President Barrett; H. W. Lord, chairman of the Magnetic Amplifiers Committee; R. S. Gardner; P. L. Schmidt, conference general chairman; H. F. Storm; (*back row, left to right*) H. L. Kellogg; E. Pryor; S. W. Rinn; J. W. Francis; H. W. Patton; J. V. Cook; J. J. Suozzi, E. J. Alexander; W. H. Mutchler, Jr.

Sixth Scintillation Counter Symposium, January 27-28, 1958

The Sixth Scintillation Counter Symposium, sponsored by the AIEE, Institute of Radio Engineers, Atomic Energy Commission, and National Bureau of Standards, is scheduled for January 27-28, 1958. The meetings will be held at the Hotel Shoreham in Washington, D.C.

Scintillation Counter Symposia have been held biennally for the past decade. These symposia serve as a means for exchanging information on the latest techniques and instruments in the scintillation counter field. They bring together those who use this type of instrument and those who are charged with its development.

The program includes invited papers by experts in the field, contributed papers on components, equipments, and applications, and discussion of problems.

There will be four sessions of a half-day each covering the following: I. Phosphor and Cerenkov Scintillators, II. Photomultipliers, III. Energy and Time Resolution, IV. Scintillation Counter Applications.

An evening session will be held on January 27th at which films will be shown of some of the latest techniques for low level counting. Also papers will be given dealing with some aspects of the approach taken by other countries to the solution of the scintillation counter problem.

COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

Industry Division

Electric Welding Committee. (R. J. Krieger, *Chairman;* R. P. C. Rasmusen, *Vice-Chairman;* M. P. Cornelius, Jr., *Secretary*). In April of this year, the Electric Welding Committee assisted the American Welding Society (AWS) in presenting its 38th annual meeting in Philadelphia, Pa. Three technical sessions, one on arc welding and two on resistance welding, were sponsored by the Electric Welding Committee. The over-all meeting attendance was the highest in AWS history with a fair number of those attending being AIEE members. Much of the credit for the excellent handling of local arrangements is due the Philadelphia Section of AIEE and notably Sidney Kapell.

The Committee will sponsor one session on instrumentation for resistance welding at the 1958 AIEE Winter General Meeting in New York, N. Y. Three papers will be presented.

The Instrumentation for Resistance Welding Subcommittee has continued to work toward completing a preliminary report on its activities.

Power Division

Insulated Conductors Committee (L. E. Fogg, *Chairman;* F. M. Hull, *Vice-Chairman;* E. J. Merrell, *Secretary*). In recent years, there has been an increasing use of aerial cable in the 5- to 15-kv range. Coincident with this increased use, there have been numerous reports of unexplained failures, especially where these cables have been connected directly to overhead lines.

Recognizing this problem, the Cable Characteristics Subcommittee of the Insulated Conductors Committee appointed a Task Group to study the causes and possible remedies for this type of failure.

The work of this Task Group resulted in the presentation at the 1957 Summer General Meeting of six technical papers covering several aspects of the problem. Arrangements are being made to have these six papers assembled and bound under one cover, in which form they may be obtained from Institute Headquarters by interested engineers.

The Task Group is continuing its investigations; and as they become available, the results will be published in the form of technical papers and reports. Some phases of the work are being carried on in co-operation with the Lightning Protective Devices Subcommittee.

Science and Electronics Division

Dielectrics Committee (L. J. Berberich, *Chairman;* K. N. Mathes, *Vice-Chairman;* E. L. Brancato, *Secretary*). The Committee is continuing to devote considerable effort in developing: 1. Standard methods for the thermal evaluation of electrical insulating materials; 2. Methods for studying the corona degradation of electrical insulating materials; 3. Evaluation of electronegative gasses.

Consideration will be given to holding the Special Technical Conference on Electrical Insulation during either the Spring of 1958 or the Spring of 1959. This conference possibly will be jointly sponsored with the Rotating Machinery and Transformers Committees. Its purpose will be to review the state of the art of not only the electrical insulating materials field but also as applied to electrical equipment.

The Committee, through its Thermal Evaluation of Insulating Materials Subcommittee, has been active in contributing to the revision of AIEE No. 1, entitled "General Principles upon Which Temperature Limits Are Based in the Rating of Electrical Equipment." This new edition of AIEE No. 1 was issued in June 1957. This group also is actively contributing to work of this nature in the international area through Working Group 7 of Technical Committee 15 of the International Electrotechnical Commission, which is to meet next in Stockholm, Sweden, July 2-18, 1958.

AIEE Arkansas Section Meeting

ON FRIDAY, SEPTEMBER 20, the Arkansas Section of the AIEE held its first meeting of the 1957-58 year. New officers were recognized at this meeting and an address on "Professional Recognition through Registration" was given by R. J. Rhinehart, immediate past president of the National Society of Professional Engineers. The Executive Committee of the Section includes (*front row, left to right*) W. A. Shaffer, membership, Arkansas Power and Light Company; P. F. Crain, public relations, U. S. Army Engineer District, Little Rock, Ark.; D. A. Schmand, chairman, U. S. Army Engineer District, Little Rock, Ark.; M. M. Riggs, vice-chairman, Arkansas Power and Light Company; F. E. Kenney, director, Garner-Kenney Company; (*back row, left to right*) Howard Davenport, communications technical group, Southwestern Bell Telephone Company; R. H. Boyd, past chairman, Southwestern Bell Telephone Company; K. C. Johnson, professional engineers, Dyke Associates, Inc.; W. M. Alley, history and education, Arkansas Power and Light Company; Jess Pierce, student branch and subsection, Westinghouse Electric Corporation; L. M. Smith, power technical group, U. S. Army Engineer District, Little Rock, Ark.; and H. R. Rowe, fellowship, Line Material Company.

AIEE PERSONALITIES

G. H. Brown (M '41, F '48), chief engineer, commercial electronic products unit, Radio Corporation of America (RCA), has been appointed chief engineer, industrial electronic products. In his new capacity, he will have engineering responsibility for all RCA industrial equipment and systems, including broadcast, communications, and industrial electronic equipment, and computer, telecommunication, and industrial control systems. Dr. Brown, a 23-year veteran of RCA engineering activities, has made major contributions to radio and television broadcast communications, particularly in the fields of antenna design and uhf transmission. He has served on the AIEE Television and Aural Broadcasting Systems Committee (1949-57), and Communication Theory Committee (1955-57).

C. W. Franklin (M '24, F '44), electrical engineer, Consolidated Edison Company of New York, has been named chairman of the Engineering and Operating Division Executive Committee of the Edison Electric Institute. Mr. Franklin has served on the following AIEE Committees: Power Transmission and Distribution (1933-37); Production and Application of Light (1935-37); Board of Examiners (1945-55, chairman 1952-54); Lamme Medal (1954-58, chairman 1956-58); and Professional Development and Recognition Department (1956-57).

Samuel Bousky (AM '46), assistant to the president, Chicago Aerial Industries, Inc., Melrose Park, Ill., has been named director of engineering. In this newly created post, Mr. Bousky will combine the firm's engineering, research, and systems development departments into a unified technical organization.

Lanier Greer (M '42, F '53) consulting engineer, d-c machinery, Reliance Electric & Engineering Company, Cleveland, Ohio, has been named to the dual positions of chief d-c engineer and chief insulation engineer for the company. Mr. Greer is past chairman of the Erie, Pa., Section AIEE. He has served on the following AIEE Committees: Mining and Metal Industry (1948-57), Rotating Machinery (1951-57), and Dielectrics (1955-57).

E. F. Weaver (AM '26, M '39), recently retired superintendent of tests, Pennsylvania Power & Light Co., Hazelton, Pa., has accepted a position with Gilbert Pacific, Inc., as project manager of the Island Power System on Okinawa, Ryukus Islands. Mr. Weaver served as an officer of the Lehigh Valley Section for many years, including a term as chairman. He served on the AIEE Safety Committee (1954-57), and Power Division Committee (1954-57).

M. M. Haertig (AM '43), engineer, technical products department, General Electric Company (GE), Syracuse, N. Y., has been appointed sales and service specialist for GE closed-circuit television in the Southwest and South Atlantic Districts.

A. E. Harrison (M '55), eastern region commercial representative to the Bell System for the Washington (D. C.) Office of Lenkurt Electric Company, has been promoted to eastern area Government and industrial sales manager.

P. R. Perino (AM '53), head of instrument engineering for Aerojet-General Corporation, has joined the staff of the Allegany Instrument Company at Cumberland, Md., as project engineer.

R. F. Gheen (AM '25), district manager of the Los Angeles (Calif.) Office of the Ohio Brass Company (O-B), will retire January 1, 1958. Mr. Gheen has served utilities and manufacturers in the Los Angeles area for the past 32 years. **V. L. Crabb** (M '48), district manager for the southern Ohio, Indiana, and Kentucky territory of the company, will become O-B's Los Angeles district manager upon Mr. Gheen's retirement.

D. D. Coffin (AM '25), manager of the Missile Systems Division, Raytheon Manufacturing Company, has been elected a vice-president of the company.

H. S. Goldberg (AM '46), manager of the engineering fabrication department, Emerson Radio & Phonograph Corporation, has joined Consolidated Avionics Corporation as chief development engineer.

K. A. Lang (M '46), manager of the Lindberg-Fisher Melting Division, Lindberg Engineering Company, Chicago, Ill., has been appointed general manager of the company's manufacturing plant in Downey, Calif.

E. C. Bowen (AM '51), test associate engineer, Endicott Testing Laboratory, International Business Machines Corporation, has been appointed test staff engineer.

D. C. Fulton (AM '39), manager of the Marine Section steam sales department, Westinghouse Electric Corporation, has been appointed manager of the heat transfer apparatus department for the Steam Division of Westinghouse.

T. P. Evans (AM '43), deputy director of research and development, American Machine & Foundry Company, has been appointed director of research and development of the company.

OBITUARIES

Henry Ellis Warren (AM '02, F '48. Member for Life), president, Lombard Governor Corp., Ashland, Mass., and pioneer in the development of the electric clock, died recently at the age of 85. Mr. Warren was born in Boston, Mass., May 21, 1872. He received the B.S. degree in 1894 from Massachusetts Institute of Technology. From 1897 to 1902, he served as engineer for the Saginaw Valley Traction Company, and from 1902 to 1920, as superintendent and as consulting engineer of the Lombard Governor Company. He became president in 1937. For many years he also was president of the Warren Telechron Company, which he founded in 1912 as the Warren Clock Company to make battery-operated clocks. He first utilized alternating current for the purposes of time keeping in 1916. Mr. Warren was awarded the 1934 AIEE Lamme Medal ". . . for outstanding contributions to the development of electric clocks and means for controlling central station frequencies." In 1935, he received the John Price Wetherill Medal of the Franklin Institute. From 1919 to 1940, Mr. Warren had been a consulting engineer for the General Electric Company. He held over 100 patents and had presented several technical papers before the Institute and other organizations.

Herbert F. Weckwerth (AM '26, M '48), manager, Electric and Water Departments, City of Kaukauna, Wis., died recently. Mr. Weckwerth was born July 1, 1897, in the town of Shields, Marquette County, Wis.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until December 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before December 26.

57-199 (formerly **56-142**) **Shifting Counters.** *C. Eldert, H. J. Gray, Jr., H. M. Gurk, M. Rubinoff*

57-673 **Matrix Analysis of Logical Networks.** *E. J. Schubert*

57-777 **Dynamic Representation of a Hydraulic Constant-Speed Drive.** *P. E. Smith, Jr.*

57-778 **Optimizing Control Systems.** *R. L. Cosgriff, R. A. Emerling*

57-1037 **Analysis of Multiple Sampler Systems with Finite Pulse Width (Open Loop).** *G. Farmanfarma*

Preprints may be purchased at 40¢ each to members 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

He received the B.S. degree in E.E. from the University of Wisconsin in 1923. From 1923 to 1926, he was employed by the Northern Indiana Public Service Company, Hammond, Ind. In 1926, he became associated with the Electric and Water Departments, City of Kaukauna, where he was appointed manager in 1928. Mr. Weckwerth was a registered professional engineer in the State of Wisconsin. He was a member of the Wisconsin Society of Professional Engineers, National Society of Professional Engineers, and the American Water Works Association.

Sam Ein (AM '38, M '44), senior engineer, Inland Steel Company, East Chicago, Ind., died recently. Mr. Ein was born December 30, 1896, in Russia. He received a B.S. degree in E.E. from Purdue University in 1923. He was a member of the Association of Iron and Steel Engineers.

George W. Weller (M '46), electrical engineer, R. W. Berger & Associates, Mansfield, Ohio, died recently at the age of 63. Mr. Weller was born February 5, 1894, in Hyndman, Pa. He received a B.S. degree in E.E. from Pennsylvania State College. During his career, he had experience with several firms including Union Switch and Signal Co., Pittsburgh Electric Furnace Corp., and Empire Steel Corp. Mr. Weller was a member of the Association of Iron and Steel Engineers. He was a registered professional engineer in the States of Ohio and Michigan.

Karl John Mertz (AM '17, Member for Life), retired, formerly superintendent of electric meters, Northern States Power Company, died recently. Mr. Mertz was born June 15, 1890, in Hastings, Minn. He received a B.S. degree from the University of Minnesota in 1914. Following graduation, he joined the St. Paul Gas Light Company. Mr. Mertz was a life member of the St. Paul Engineering Society. He had been an active member of the Minnesota Section of AIEE, serving as chairman in 1941.

Ansel A. Packard (AM '20, M '26, Member for Life), division manager, Connecticut Power Company, Middletown, Conn., died recently. Mr. Packard was born June 21, 1894, in Brockton, Mass. He received the B.S. degree in E.E. in 1916 from the University of Maine and the E.E. degree in 1920. He joined the Connecticut Power Company in 1917. Mr. Packard had been an active member of the Connecticut Section of AIEE.

Francis Joseph Adams (AM '04, M '13, F '51, Member for Life), professor of electrical engineering, Worcester Polytechnic Institute, Worcester, Mass., died recently. Prof. Adams was born December 18, 1880, in Maynard, Mass. He attended Worcester Polytechnic Institute, receiving the B.S. degree in E.E. in 1904 and the E.E. degree in 1906. He joined the faculty as an instructor in electrical engineering in 1907. In 1931, he was made a professor. Prof. Adams also had experience in industry with the Westinghouse Electric Corporation, Worcester Electric Light Company, and New England Power Service Corporation. He was a member of the American Society for Engineering Education.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of October 17, 1957, recommended the following applications for transfer. Any objection to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Angell, J. B., research section manager, Philco Corp., Philadelphia, Pa.
Black, D. G., Jr., production manager, Harris Transducer Co., Woodbury, Conn.
Bowman, J. W., supervisor, division relay & communication dept., Indiana & Michigan Electric Co., Ft. Wayne, Ind.
Brandt, F. W., electrical engineer, Ebasco Services Inc., New York, N. Y.
Buck, D. E., plant extensions engineer, Southern Bell Tel. & Tel. Co., Atlanta, Ga.
Campbell, J. C., Jr., relay engineer, Nashville Electric Service, Nashville, Tenn.
Clapp, G. H., sales engineer, apparatus dept., Westinghouse Elec. Corp., Butte, Mont.
Crippen, R. D., electrical engineer, engineering dept., International Nickel Co., Inc., Huntington, W. Va.
Cronin, J. H., district line engineer, Duquesne Light Co., McKeesport, Pa.
Davenport, E., electrical designer, Barvic Engineering Ltd., Vancouver, B.C., Canada
Devine, M. E. C., area manager, Westinghouse Electric Corp., Hartford, Conn.
Dudley, C. E., engineering consultant, 229 Eastgate Dr., Corpus Christi, Texas
Edenborough, L. A., area engineer, Public Service Co. of Oklahoma, Okmulgee, Okla.
Eliander, H. F., Jr., research engineer, Boeing Airplane Co., Seattle, Wash.
Ferrante, J. F., manager, Engineering Div., Tobe Deutschmann Corp., Norwood, Mass.
Ferrell, A. A., assistant section supervisor, Tennessee Valley Authority, Chattanooga, Tenn.
Fraser, J. C., engineer, General Electric Co., General Elec. Lab., Schenectady, N.Y.
French, R. X., Jr., electrical engineer, Sargent & Lundy, Engineers, Chicago, Ill.
Fuller, G. W., staff engineer, The Empire District Electric Co., Riverton, Kans.
Garcia, V. A., acting division chief, Telecom. Div., US AEPG Signal Communications Det. Ft. Huachuca, Ariz.
Giroux, V. A., electrical engineering associate, Dept. of Water & Power, Los Angeles, Calif.
Hardman, T. F., supervisory engineer, Westinghouse Electric Corp., Lima, Ohio
Holland, H. L., electrical engineering associate, Dept. of Water & Power, Los Angeles, Calif.
Holzmann, E. G., engineer-process dynamics, General Electric Co., San Jose, Calif.
Horton, W. A., Jr., engineer, Columbus & Southern Ohio Electric Co., Columbus, Ohio
Horton, W. F., group engineer, Lear, Inc., Santa Monica Calif.
Jerencsik, A. P., technical advisor, Battelle Memorial Institute, Columbus, Ohio
Jimenez, A. C., electrical engineering consultant, Engeering & Development Corp. of Philippines, Manila, Philippines
Kaisner, R. W., engineer, manager of instrument branch, ARO, Inc., Tullahoma, Tenn.
Kay, W. K., associate professor, U.S. Naval Academy, Annapolis, Md.
Levine, D. B., advanced development engineer, General Electric Co., West Lynn, Mass.
McCarvel, J. M., supervising electrical engineer, Westinghouse Elec. Corp., Butte, Mont.
Muller, R. A., maintenance engineer, Michigan Bell Telephone Co., Detroit, Mich.
Nichols, C., head, utilities section, Application Engineering Div., Leeds & Northrup Co., Philadelphia, Pa.
Owen, R. K., assistant industrial engineer, Southwestern Public Service Co., Amarillo, Texas
Padfield, A., general foreman, Pennsylvania Railroad Co., Philadelphia, Pa.
Paradis, G. D., engineer, Philadelphia Electric Co., Philadelphia, Pa.
Perry, G. H., assistant superintendent (power dept), Ethyl Corp., Baton Rouge, La.
Propst, R. F., distribution products specialist, General Electric Co., Atlanta, Ga.
Richer, B. F., advanced engineer, Westinghouse Electric Corp., Lima, Ohio
Ross, N. O. vice-president & general manager, St. Lawrence Power Co., Ltd., Cornwall, Ont., Canada
Schamberger, J. M., assistant electrical engineer, Connecticut Light & Power Co., Hartford, Conn.
Shaw, N. C., engineering group leader, A. W. Haydon Co., Waterbury, Conn.
Sinclair, K. J., engineer, American Tel. & Tel. Co., Kansas City, Mo.
Smith, D. D., electrical engineer, National Advisory Commission for Aeronautics, Langley Air Force Base, Va.
Sonnenschein, A. H., chief systems engineer, Polarad Electronics Corp., Long Island City, N.Y.
Sparrow, E. C., Jr., supervising electrical engineer, U.S. Bureau of Reclamation, Sacramento, Calif.
Tribken, E. R., engineering dept. head, Sperry Gyroscope Co., Great Neck, N.Y.
Wallace, J. H., Jr., specialist installation & service engineer, GE Co., Dallas, Texas
Westhoefer, D. L., engineer, Hilscher Clarke Electric Co., Canton, Ohio

50 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of member have been received from the following candidates and any member objecting to election should so notify the Secretary before December 25, 1957, or February 25, 1958, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Broadbent, D., associate professor of electrical engineering, Cornell Univ., Ithaca, N.Y.
Champney, G. W., senior design engineer, Westinghouse Electric Co., East Pittsburgh, Pa.
Craig, M. J., consulting engineer, Craig Engineering Co. Chester, S.C.
Drown, J. L., supervisory engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Fritsch, C. E., senior electric engineer, Harza Engineering Co., Chicago, Ill.
Greve, T. E., president, T. E. Greve Electric Co., Houston, Texas
Henkle, C. V., design engineer, Koebig & Koebig, Los Angeles, Calif.
Hill, I. A., product engineer, Paranite Wire & Cable Co., Marion, Ind.
Hix, I. M., senior engineer, IBM Co., Endicott, N.Y.
Hulls, L. R., senior application engineer, Canadian Westinghouse Co., Hamilton, Ont., Canada
Hurt, A. R., special studies engineer, Southern Bell Telephone Co., Atlanta, Ga.
Khan, M. F., in charge workshop, Surveyor General, Murree, West Pakistan, Pakistan
Lesh, A., design engineer, Lockheed Aircraft Corp., Burbank, Calif.
Minchin, A. C., supervisor, electric diagrams, Philadelphia (Pa.) Electric Co.
Moseley, S. T., associate professor–electrical engineering, University of South Carolina, Columbia, S.C.
Oliphant, K.S., consulting engineer, 41 Sutter St., San Francisco, Calif.
Ringlee, R. J., supervisor design, General Electric Co., Pittsfield, Mass.
Robertson, J. N., assistant design group leader (electrical), Dept. of Water & Power, City of Los Angeles, Calif.
Staebler, L. A., manager of advanced engineering, Philco Corp., Philadelphia, Pa.
Thomander, V. S., general engineering, Westinghouse Electric Corp., Newark N.J.
Wright, H. A., electrical engineer, 251 Kearny St., San Francisco, Calif.

21 to grade of Member

ELECTRICAL ENGINEERING EDUCATION

AIEE in Case Institute of Technology

FOUNDED IN 1905 as the "Electrical Club," the AIEE appeared on the campus of the Case Institute of Technology, Cleveland, Ohio, as a Student Branch in 1920. At present, the organization meets once every two weeks. Special meetings are called mainly for inspection tours of Cleveland area industrial plants.

The Case electrical engineering department moved, in 1955, into the $1.6 million William E. Wickenden Building (*right*) which features ideal lighting and climatic conditions, adequate space for teaching, laboratory work, and research, and a closed circuit television network with sending and receiving facilities in every major room.

In its new Electrical Engineering Building, Case has up-to-date equipment for study in industrial electronics, communications, control mechanisms, ultrahigh frequencies and microwaves, and high-speed computing.

Courtesy Rehman Photo Service

Transients and Crises— An Essay on Common Sense

W. L. EVERITT
FELLOW AIEE

SOME YEARS AGO, the sister of Karl Compton, whose husband was the head of an educational institution abroad, was having her house wired by a native electrician who constantly came to her with questions such as "Where do you want the wires?" "How many plugs?" "Do you want three-way switches?" She finally said, "Oh, you know what I want, just use your common sense." He replied politely: "Madam, common sense is a gift of God. I have only a technical education."

In contrast to that electrician, educators believe a technical education should develop and enhance the use of common sense, and that an engineer could not survive professionally without it. Individual definitions of common sense may vary, but my own is: "Common sense is the ability to use past experience in the solution of new problems." A recognition of the principle of my definition is why teachers so commonly reason and teach by analogy and the use of metaphors, a habit which will show up in my talk today. Quite naturally my illustrations will be drawn from the field of electrical engineering.

Response of W. L. Everitt, dean of the College of Engineering, University of Illinois, upon the presentation of the AIEE Medal in Electrical Engineering Education at the AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, 1957.

Some Background

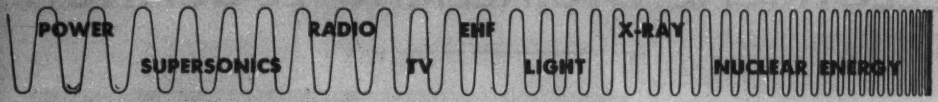
The theory of circuits is the major foundation for work in our profession. Formerly, we divided this subject into two areas, transient and steady-state phenomena. When I was a student, we were given the impression that transients were of only transient interest (really not surprising) and that the steady-state was the more natural and durable condition of circuit life. Nowadays, we are more interested in the response of circuits to rapid changes of random nature. Actually, in communication systems, only continual and unexpected changes convey any information to make the system useful.

Fortunately for our peace of mind, we found a unifying approach which had been available all the time in the works of Fourier and Laplace, although we needed help from mathematicians and their disciples to interpret the teachings of these classical leaders. Hence, the properly educated electrical engineer, conversant with the theory of the complex variable and the Laplace transform, now finds little difficulty in analyzing the response of circuits with a moderate number of degrees of freedom. If he also has available a digital computer and is conversant with its use, he can tackle with confidence a problem involving many degrees of freedom.

Life Among the Transients

These are times when we are exposed both as nations and as individuals to explosive and startling changes of great variety and degrees of intensity in politics, in economics, and in technology. One can say we are living in a world of "transient phenomena." Furthermore, these eruptions are separated by shorter and shorter intervals. Their random nature, both in time and in character, keeps us from considering them as in the realm of "repeated transients," which can approach the nature of steady-state phenomena. Furthermore, the character of these transient excitations is such that some represent signals to which we should respond in a significant manner, others would qualify only as noise which the discerning individual must learn to discard as insignificant.

Electrical Engineering Education



An Analogy for Education

In the planning of our educational programs, particularly those in engineering, we must take account of the nature of this world as it is, and even as it may be in the future. The circuit analogy gives me hope that there are possibilities for an organized approach to the preparation of students for meeting many types of change with the confidence of well-developed ability. Such an approach may involve, however, not only modification in the curriculum, but also define changes in our methods of teaching.

First, let me point out a wrong and dangerous type of approach, both for our engineers, and for our nation generally. I would call this the "crisis" or "alarmist" attack. In recent years, political commentators, to develop daily or weekly excitement, have predicted or announced "crisis" after "crisis." Unfortunately, writers and speakers on education have been running these prophets of doom a close second.

Webster defines a crisis as "a state of things in which a decisive change one way or the other is impending . . . a time of difficulty, danger, and suspense." It seems to me that both the Webster definition and the popular conception of a "crisis" imply that it is a situation to be approached with fear and trembling, almost inevitably accompanied by a sense of helplessness and inadequate preparation.

Now I would not deny that crises have existed and may exist again. When the Goths advanced upon Rome or when sanity yielded to terror at Munich, crises truly existed. If guided missiles are ever dispatched with live war heads, no less a term can be applied.

But repeated exaggerated cries of alarm produce only the well-recognized result of the old fable. Perhaps it is time, therefore, to barbecue our wolves and develop a program of education particularly adapted to a world where rapid change and the repeated impacts of exciting new problems needing solution will be the norm. World War II certainly showed how, when hardened by experience, prepared by proper training, and buoyed by high ideals, humans can react to extreme stress with amazing vigor and success. By contrast, recent observations on "brain washing" have shown that a lack of preparation makes breakdown under strong stress increasingly probable.

If we, our colleagues and our students, are to meet new stresses or pressure situations continually, is it not proper:

1. To stop calling every new and difficult problem a "crisis," thus implying an attitude of terror and helplessness.

2. To develop a frame of mind which replaces dismay with confidence in our ability to adapt to a changing world, as our past experience has shown is possible.

3. To place greater emphasis, in the education of our youth, on preparation to meet new situations of all degrees of intensity, on programs which will give the graduate experience in improvising on the basis of a sound education, in other words to exercise his "common sense."

Electrical engineering education in the past quarter century has changed its curriculum dramatically. As new but essential material has appeared, such as the knowledge of solid-state physics which gave birth to the transistor, or as more complicated devices and situations have indicated a need for deeper understanding of the classic works, such as those of Maxwell, we have introduced the needed topics first in the graduate and then in the undergraduate programs. Room for such additional material has been secured by analyzing the diverse responsibilities of the university and industry for the education of the engineer. That which is specialized and can best be learned in industry has tended to be removed from the university portion of engineering education and postponed for industry to treat.

In addition, constant and hard work has organized the study of what were once considered very difficult concepts into forms which have made these concepts more teachable. There has also been a constant improvement in the familiarity of students with mathematical reasoning, so that it is now less common to pick up a textbook which boasts of avoiding the use of mathematics or to meet a professor who glories in such an approach.

However, this very necessity to teach more difficult ideas may, perhaps unwittingly, have caused us to increase the amount of predigestion of the intellectual food offered to our students. Although students assure us there is still an adequate, perhaps too great, supply of tough muscle and roughage in their intellectual diet, I would question whether we are providing in our college teaching enough experience in meeting the unexpected, and meeting it in such a way that the student must learn to work out his own salvation through the exercise of judgment and imagination.

Laboratory Hardening

Engineers have always been the leading exponents of the laboratory method of learning by experience in controlled situations rather than by either word descriptions of such situations alone, or by postponing contact until a time when their proper solution may be a matter of technical life or death. Generally speaking, the situations presented in our classes and laboratories have been too near the ideal. The student has not learned to sort out the relevant from the irrelevant, because just the right amount of information, neither too much nor too little, has been provided in the problems presented to him. Such a situation never exists in real life. So what I am proposing is a "laboratory" approach to the meeting of new, complex, undiagnosed, and undigested situations.

It is recognized that full development of the ideas presented here is somewhat inhibited by the amount of material which must now be concentrated in an undergraduate curriculum, particularly the most common four-year variety. The practical disappearance of the undergraduate thesis is an indication of this trend. But proper attention to teaching methods may still make it possible to introduce into the normal undergraduate program an appreciable amount of the type of experience I recommend.

Optimum Graduate Programs

Further thought leads us to question whether there is any particular group among our students who should be prepared especially to meet the unexpected, to respond gleefully to new situations with vigor and ingenuity. It seems obvious that such a group should be composed of those whom we expect to see as leaders.

To me this points up two inevitable conclusions:

1. Engineers, more and more, particularly electrical engineers, should plan on graduate work, either in their own and closely related fields or in more distant ones such as law, business, psychology, medicine, or even theology. The most able students should recognize this not only as an opportunity but as an obligation. And society, particularly industry, should make this extended education possible.

2. Graduate teaching, above all, should give intensive attention to the development of ability in meeting the unexpected.

At this time, I would like to indicate that I also think a larger and larger proportion of graduate education should be done in residence, that is, as a full-time program at an educational institution. Engineering is progressing toward recognition as a leading (perhaps the leading) profession. When it is recognized that most bachelor's degrees in engineering, advanced degrees in physics and chemistry and law, and all degrees in medicine are secured in residence, I doubt if advanced degrees in engineering can be

given adequately on a part-time basis or by professors traveling away from the campus.

Good professional education is difficult to develop simultaneously with a full burden of professional work in the daytime, particularly when this double load commonly exists concurrently with the establishment of family responsibilities and accommodation to a new community environment. Moreover, the selection of the educational institution should be based on the interest of the student in the faculty and offerings, not on geographical proximity to a job.

I must assure you I believe strongly the universities should assist industry even more than they do at present in upgrading employed professional engineers by supplementing undergraduate education with a variety of special courses. I am only questioning the amount of emphasis industry is giving currently to "on-the-job" degree programs as a recruiting and employment incentive.

Resident university instruction has many advantages which are lost in part-time programs. Only a fraction, one might say only a small fraction, of the values of graduate study are obtained by mere course work alone. The more intimate extended contact with the best minds on the faculty, the interchange of ideas among a student group of cosmopolitan interests, the time, energy, and desire to explore one's own grounding in fundamentals and the extensive use of adequate library facilities are all major parts of a good graduate program.

Unfortunately, there is too much worship at the present time of the degree itself, rather than the educational experiences which have made the holders of these degrees so valuable. If advanced degrees are to maintain their worth, both the educational institutions and industry itself must unite to see that future masters and doctorates do not represent a debased currency.

Responsibility for the Future

Electrical engineering is now at the intersection of two very busy technical thoroughfares—it has major functions in the "processing of information" and also in the "processing of energy." Its practitioners are called upon more and more to understand the intricate physical nature of the special materials with which they deal. In this position, we have an obligation to endeavor to understand not only ourselves but nearly every other branch of learning. We must function jointly with other engineers and business leaders. Such team action requires that we have adequate training in a common language. Furthermore, our own peculiar knowledge of how to measure and control by electrical means almost everything measurable or controllable (except our wives) and with a minimum of disturbance to the phenomena controlled, indicates that we have both the ability and obligation to make major contributions in such fields as psychology, biology, medicine, agriculture, economics, banking, and others.

In short, our information-processing systems are rapidly providing brain power, or at least assistance to brain power, as well as supplementary nervous systems for our modern social order and components thereof. We must even admit responsibility for the comment of an individual who said, "Have you ever observed how much more intelligent than people machines are becoming?" And modern people, most of all modern children, are no longer amazed at anything. A small youngster of one of our visiting professors from abroad commented last year, "Wasn't it wonderful how quickly our radio learned to speak English?"

It is obvious that we can never hope to prepare our students in four, five, or seven academic years to understand all the fields on which they may have impact or which will vitally affect them; therefore, rather than expecting to teach something about each area of importance, our philosophy of education must inevitably depend upon the definition of a college education which I first heard given by our own Dr. A. W. Hull when he said, "The advantage of a college education is that it gives one confidence in his ability to learn." In order to have such a confidence, however, our students, particularly our graduate students, must be introduced sufficiently to the general fields of the social studies and humanities so that they can read with appreciation, select with discernment, and converse without diffidence in those fields as well as in the physical sciences and engineering. We must overcome the attitude, at least as far as engineers are concerned, implied in the remark, "A historian and an anthropologist can no longer have a discussion unless they select some common ground like the Cleveland Indians."

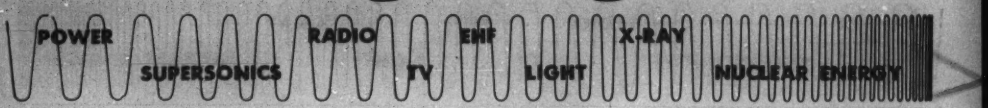
Conclusions

In summary, I suggest:

1. Frequent change is a way of life to which we must become accustomed.
2. Our educational methods should take this fact of life into account, and provide "laboratory" experiences in meeting new and unexpected situations.
3. Undergraduate curricula are necessarily so crowded that adequate education in problems of the type too frequently

Courtesy F. R. Danster

DR. W. L. EVERITT (*right*), dean of the College of Engineering, University of Illinois, receives the AIEE Medal in Electrical Engineering Education from W. J. Barrett (*second from left*), AIEE president, during the opening general session of the 1957 AIEE Fall General Meeting at the Hotel Morrison, Chicago, Ill. Observing the presentation are E. C. Jordan (*left*), head of the electrical engineering department, University of Illinois, who gave the career of the medalist, and W. R. Brownlee (*second from right*), chairman of the AIEE Recognition Awards Committee.



referred to as "crises" can best be given in graduate work.

4. More of our technical leaders will need to take graduate degrees in order to function adequately as professional men.

5. It will be highly advantageous both to the individual and to industry if the greater number of students working for advanced degrees do so in full-time residence at the educational institution of their choice.

6. Electrical engineers have a great deal to contribute in many fields of activity. The range of possible contributions is so great that our educational program can never give adequate coverage of subject matter, but must produce in our students a confidence in their ability to learn, an eagerness to tackle, and an ability to solve new and difficult problems.

And so I will not wish either the present or future electrical engineers smooth sailing, but promise them instead a busy, exciting, and rewarding life on the stormy seas ahead.

Nuclear Training Center To Be Set Up in Puerto Rico

The U. S. Atomic Energy Commission (AEC) and the University of Puerto Rico recently signed a contract for the operation of a new Nuclear Training Center to be constructed in Puerto Rico by the AEC.

The Nuclear Training Center was authorized by the last session of the U. S. Congress and $2.8 million was appropriated for the start of construction and initial operation of the Center.

At the same time the AEC announced the appointment of J. I. Thomas, former deputy manager of its Hanford Operations Office, Richland, Wash., as resident manager of a new permanent AEC office being established in Puerto Rico. Mr. Thomas has been in the atomic energy program for six years. The Puerto Rico Area office will administer the contract between the University of Puerto Rico and the AEC.

The goal of the Center is to develop a comprehensive program for research and training—in the Spanish language and available to students from the American Republics—in nuclear science and engineering and the peaceful applications of nuclear energy in medicine, agriculture, and industry. The University of Puerto Rico is a charter member of the Union of Latin American Universities and during the 1956-57 academic year had 313 students from 19 American Republics in its student body. The total enrollment is more than 16,000 with a full-time faculty numbering 1,064. Under the contract, the AEC will bear the expense of installation and operation of the Center and the University will operate and manage it without a fee.

The contract will be similar to one which the AEC has with the Oak Ridge Institute of Nuclear Studies (ORINS) for operation of educational and research facilities at Oak Ridge. ORINS is an organization composed of 35 American colleges and universities, one of which is the University of Puerto Rico.

In the first phase of the program to be started in 1957 and completed in 1960, a 1,000-kw pool-type reactor and a training facility will be built at the College of Agriculture and Mechanical Arts at Mayaguez. Preliminary plans provide for later construction of a training and research building for medical and biological applications of nuclear energy to be located near the new Medical Center in Rio Piedras, and some additional training and laboratory facilities at Mayaguez.

The need for the nuclear center became apparent at the Symposium on the Peaceful Applications of Atomic Energy conducted at the University of Puerto Rico in January 1957. More than 1,200 students, government officials, and educators attended the sessions which were held both at the Rio Piedras and Mayaguez campuses.

Following this symposium, the Mayaguez school initiated a training program in nuclear science and technology and the Rio Piedras school started instruction in radioisotope techniques. These activities will become a part of the program of the Nuclear Center.

The Area Office of the Commission, which opened October 21, is located initially at Mayaguez, and will report to the Oak Ridge Operations Office.

Tau Beta Pi Holds 52nd National Convention

Tau Beta Pi's 52nd national Convention was held at the University of Wisconsin in Madison and at Marquette University in Milwaukee, October 9-12, 1957. The Wisconsin Alpha chapter at the University of Wisconsin and the Wisconsin Beta chapter at Marquette University were official hosts, and all but one of the 99 collegiate chapters were represented at the session. The convention was also attended by Tau Beta Pi's national officers headed by President H. M. King, retired General Electric Company turbine engineer, of Swampscott, Mass.

The convention, headquartered at the University of Wisconsin's Memorial Union on October 9 and 10, and at Marquette University's Brooks Memorial Union on October 11 and 12, consisted of four business meetings, several specially arranged discussion periods, and a banquet program of particular interest. Plans for the national meeting were made under the direction of S. A. Woll, president, and D. E. Tormey, arrangements chairman, of the University of Wisconsin host chapter, and J. C. Donovan, president, and J. G. Skach, arrangements chairman, of the host chapter at Marquette University. P. H. Robbins, executive director of the National Society of Professional Engineers, Washington, D. C., and Tau Beta Pi's director of fellowships, served as chairman of the convention business meetings.

A major item of business on the convention agenda was the election of a new Executive Council for the four-year term starting December 1958. Three slates of five candidates each had previously been nominated by the two Wisconsin chapters, by five Southeastern chapters, and by the Chicago (Ill.) area chapters at Northwestern Technological Institute and Illinois Institute of Technology. The Chicago slate was elected. It comprises Dr. O. W. Eshbach, retired dean of engineering at Northwestern Technological Institute, A. W. Consoer, consulting engineer of Chicago, Dr. G. G. Lamb, of the chemical engineering faculty at Northwestern, Dr. P. D. Manning, vice-president for research of the International Minerals and Chemical Corporation in Chicago, and Dr. R. G. Owens, dean of engineering at Illinois Institute of Technology.

The convention granted a new chapter of Tau Beta Pi to the local engineering honor society at the University of South Carolina, which had submitted a petition for a charter last winter. The South Carolina society was represented at the convention by its faculty advisor, Dr. T. H. Wilson, and its student president, C. M. Stork. The new chapter, to be designated South Carolina Beta, will be installed this winter as Tau Beta Pi's 100th active undergraduate chapter.

The convention voted to hold the 1958 national meeting in October in Boston and Cambridge, Mass., with all five Massachusetts Tau Beta Pi chapters as official hosts. The joint invitation for the next conventon was extended by the chapters at Worcester Polytechnic Institute, Massachusetts Institute of Technology, Tufts University, Northeastern University, and the University of Massachusetts.

A major event of the convention in Wisconsin was the initiation and banquet on Friday evening, October 11, in Milwaukee. The initiation ceremony was conducted by the Executive Council and officers of Tau Beta Pi for 14 students of Marquette University and for 7 prominent professional men, 4 of whom had been elected to Tau Beta Pi membership by the University of Wisconsin chapter and 3 by the Marquette University chapter. One of these was J. H. Smith, professor

of economics at the University of Wisconsin in Milwaukee and former president of the General Electric Company's X-ray Division, who delivered the major address on the initiation banquet program, entitled "New Frontiers for the Engineer." Other speakers on the program were Dean K. F. Wendt of the College of Engineering at the University of Wisconsin and Dean A. B. Drought of Marquette University's College of Engineering.

Valuable features of Tau Beta Pi Conventions are the chapter-work discussions and the exhibits at which ideas for school and community service projects and chapter administration are exchanged by the delegates, most of whom are presidents of their local groups. This year's discussions in that field were again led by students under the general direction of M. E. Van Valkenburg of the University of Illinois, Chapter Co-ordinator for Tau Beta Pi.

Tau Beta Pi is a national engineering honor society which was founded at Lehigh University, Bethlehem, Pa., in 1885. It now has 99 undergraduate chapters in United States engineering colleges, 26 alumni chapters, and over 93,000 initiated members. Students are elected to membership by the chapters from the top 20% (scholastically) of their engineering classes on the basis of character and service to their colleges. Alumni may be elected on the basis of eminent achievements in the engineering profession.

Tau Beta Pi's present Executive Council, or board of directors, includes five alumni members who live in or near Boston, Mass. In addition to President King, the council includes Vice-President W. C. Voss, consulting engineer and retired head of the building engineering and construction dpartment at Massachusetts Institute of Technology; Dr. L. W. Bass, of the executive staff of A. D. Little, Inc.; Dr. C. F. Muckenhoupt, chief scientist of the First Naval District; and Dr. H. K. Brown, research mathematician with the Avco Corporation.

U.S. Navy Yard and Pratt Sponsor 5-Year College Program

On Wednesday, October 16, following a luncheon, Official Greetings to Pratt Institute were accorded 58 engineering students registered in the 5-year college training program jointly sponsored by the United States Naval Shipyard and Pratt Institute. The 58 (including one girl) spent the summer in Navy Yard workshops and started classes at the Institute in the Fall. Pratt officials report that first test marks confirm that these students, selected on a competitive basis from high school graduates in the entire Metropolitan area, are of the highest academic caliber. Representing Pratt Institute at the Greeting were W. E. Wilson, dean of the School of Engineering; representing the U. S. Navy, Commander L. B. Mayer, industrial relations officer; Dr. Theodore Zaner, industrial relations assistant; and Edward Mallon, of the industrial management office.

Students accepted under this program attend full-time classes the first and fifth years, with tuition paid by the shipyard, and during the second, third, and fourth years, attend classes half-time at their own expense, being employed the other half-time, with pay, by the shipyard. On graduation, students must continue service as a full-time Navy employee, one year of service for each year for which assistance was provided.

An Electrical Engineer in Education

M. S. COOVER (AM '16, F '42), administrative assistant, Division of Engineering, Iowa State College, Ames, Iowa.

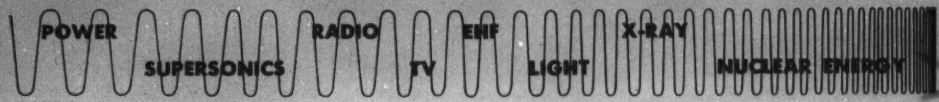
"The AIEE offers a lasting tie between the electrical engineering educator and his chosen field of endeavor. Through the Student Branches, it offers the educator tremendous opportunity to stimulate young men to be professionally conscious and to influence their thoughts toward personal growth and professional development. It offers continuous opportunity to stress the importance of never losing sight of the code of principles of professional conduct. The educator has never-ending opportunity to point out to his students that the AIEE is a progressive, productive, dynamic organization and that active participation in its affairs can enrich their professional stature.

"To build a professional background is to work on a structure that never can be considered as having been completed. Quality education on the part of the teacher stems from a thorough knowledge of the subject, his technique on imparting information effectively, and his ability to inspire creative thinking. Quality education on the part of the student comes from a deep-seated love for his chosen profession, his anxiety to learn, his delight in mastering what to many are difficult assignments, and the manner in which he recognizes the value of human relations. When genuine interest exists, no educator will be undersalaried in the intangible currency of satisfaction that comes from seeing his one-time students achieve successful careers.

"Electrical engineering educators can find in their AIEE organization many valuable sources of information and constructive ideas for upgrading curriculum content and keeping alive their own personal advancement. Enthusiastic participation in AIEE committee activities, technical conferences, and meetings can enhance their own professional background. However, in the long run, it is not what one gets out of the Institute, but what one puts into it that really counts."

Mr. Coover, who served as president of the AIEE, 1956-57, was born in Shippensburg, Pa., on December 9, 1890. He was graduated from Rensselaer Polytechnic Institute in 1914. Following a year with the New York Central Railroad and two years with the Montana Power Company, he entered the U. S. Army. In 1919, he joined the faculty at the University of Colorado where he became professor in 1930. In 1935, at Iowa State College, he was appointed professor and head of the department of electrical engineering. From 1942 to 1944, he was director of the Naval Training School—Electrical at Iowa State College. At various times during his engineering education career, he was employed by the General Electric Company, the City of Denver, the Public Service Company of Colorado, and other organizations to conduct special studies. Mr. Coover is a member of the American Society for Engineering Education, Engineers' Council for Professional Development, Iowa Engineering Society, National Society of Professional Engineers, Institute of Radio Engineers, Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu, and Sigma Tau. He has served as secretary of the AIEE North Central District No. 6, 1929-33, as vice-president of Great Lakes District No. 5, 1944-46, and has been a member of numerous AIEE National Committees.

Electrical Engineering Education



ASEE Reports on Salaries and Earnings of Engineering Teachers

The average engineering teacher in American colleges and universities earns a salary of $6,634 per year—$550 per month. He adds consulting and other engineering work to bring his total annual earnings to $8,862.

He earns more if he teaches in a privately endowed institution rather than in a public institution, and he earns more on the Pacific Coast than anywhere else.

These figures come from a new study by the American Society for Engineering Education (ASEE) of 1956 engineering salary figures originally gathered by Engineers Joint Council. The ASEE's analysis is in connection with a high-priority study of how to increase the supply of competent teachers for engineering colleges.

This analysis reveals timely additional information about the salaries and other earnings of engineering teachers by ranks, regions, and type of institution, according to W. C. White, acting chairman of ASEE's Committee on the Development of Engineering Facilities, who is vice-president of Northeastern University. "These detailed data will greatly aid the Committee in developing its basic study of over-all engineering faculty needs," he stated.

"Even while this salary report was being prepared, the Committee received growing evidence of improvements in the financial status of engineering teachers in colleges throughout the country," Mr. White declared, emphasizing at the same time that his Committee was concerned not alone with salaries but with ways and means of making careers in engineering teaching competitive in terms of total rewards and satisfactions with opportunities for talented people in nonteaching careers.

"In order to handle effectively the increased numbers of students to be enrolled in the years ahead," Mr. White said, "the faculties of engineering schools must be able to attract and hold a fair proportion of the most capable young engineering graduates."

Dr. W. H. Miernyk of Northeastern University—now a visiting professor at the Massachusetts Institute of Technology—is executive director of the ASEE committee project. He was assisted in this analysis of faculty salaries by Prof. M. A. Horowitz of the Bureau of Business and Economic Research at Northeastern.

The survey found that average salaries for young engineers serving as instructors range from $4,214 in public institutions to $4,374 in privately supported schools. Department heads' salaries average $9,117 and $9,893, respectively. Deans earn $10,932 and $11,829, respectively, on the national average.

Of the 4,000 engineering teachers surveyed, 80% earned income beyond their teaching salaries from the practice of engineering. Instructors earned an average of over $1,000, professors from $2,436 (public institutions) to $4,716 (private institutions). On the average, teachers in public institutions had outside earnings of $2,333, those in private institutions $3,634.

"Both annual incomes and basic teaching salaries of engineering teachers in privately supported institutions are consistently higher than those of teachers in publicly supported institutions," says the ASEE report.

Engineering teachers' salaries do not vary widely across the nation. Averages in public institutions range from a low of $4,086 in the mountain states to $6,886 in the midwest, in private institutions from $5,133 in the mountain states to $7,613 on the Pacific Coast.

But average annual incomes vary more, from a low of $7,319 in the mountain states to $12,500 in the Pacific states, and there is a substantial spread around the national average.

Figures released by the ASEE were based on replies from more than 4,200 engineering teachers—35% of the 12,000 engineers engaged in teaching in the United States. Revised salary data are promised in a final report together with recommendations of the Committee on the Development of Engineering Faculties. This is scheduled for release early in 1958.

The ASEE project is made possible by grants of the National Science Foundation and other private and industrial organizations.

Copies of the report may be obtained from: The American Society for Engineering Education, University of Illinois, Urbana, Ill.; 25¢ per copy.

Sixth Session of AEC Reactor School Under Way

The U. S. Atomic Energy Commission (AEC) has accepted 62 scientists and engineers, 50 of them from 21 foreign countries, for enrollment in the sixth session of the AEC's International School of Nuclear Science and Engineering at the Argonne National Laboratory, Lemont, Ill. The training program, an outstanding part of the President's "Atoms-for-Peace" program is shared by the International School and co-operating universities, North Carolina State College and Pennsylvania State University.

The enrollment brings to 355 the number of scientists and engineers pursuing the course in unclassified reactor technology. Of these, 267 have come from 42 foreign countries. The 88 American students have been sponsored largely by United States firms interested in nuclear energy.

A student from Afghanistan is the first-time representative from his country. Other nations represented in the tentative roster of the sixth session class include: Austria, Brazil, Burma, Nationalist China, France, Germany, Greece, India, Indonesia, Israel, Italy, Japan, Korea, Mexico, The Netherlands, Pakistan, Peru, Spain, Switzerland, and Thailand.

The combined training program, including North Carolina State College and Pennsylvania State University which have research reactors on their campuses, is an expansion of the earlier AEC reactor school program and doubles the number of students who can receive this training.

The course is based upon lectures and seminars and the intensive training provides a general grounding in nuclear science for those participating. Practical work then follows, with such facilities as nuclear reactors, "hot" caves, etc., for those following their specialty.

After a week of general orientation, the students were divided into two groups and these reported to Raleigh, N. C. and University Park, Pa., for the broad training program presented in the first 17 weeks of their study. The International Co-operation Administration and the Department of State provide support for many of the foreign students.

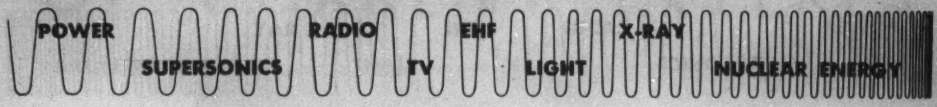
While the new group of students is beginning the broad training, the fifth session students who completed their work at North Carolina State College and Pennsylvania State University continue their advanced study at the Argonne National Laboratory.

NCR Presents Electronic Computer System to USC

Speeding new research in measuring man's intelligence is the first job given the electronic digital computer which was officially presented on September 25th, 1957, to the University of Southern California (USC) by the National Cash Register Company (NCR), Electronics Division, Hawthorne, Calif.

D. E. Eckdahl, NCR division manager, made the presentation on behalf of S. C. Allyn, chairman of the board, with Dr. A. S. Raubenheimer, USC educational vice-president, and Dr. Robert Vivian, dean of the USC School of Engineering, accepting for the university. The computer, complete with an auxiliary tap memory unit and input-output equipment, is installed in special new facilities in the USC engineering building.

In addition to making computations in engineering and the physical sciences, the computer will play an important part in



other fields of research. One example of this may lead to a comprehensive theory about the intellectual processes of man, with special emphasis on creativity.

The project is being conducted for the Office of Naval Research by Dr. J. P. Guilford, USC professor of psychology, with P. R. Merrifield as assistant director.

Installation of the NCR computer makes possible important new courses in the USC engineering curriculum. These will be taught by Prof. E. J. Jagger of the electrical engineering department, who will also supervise use of the computer equipment for the university's research studies.

"With technology now entering the computer era, we feel it extremely helpful to give students a basic understanding of computer logic and operation," Prof. Jagger stated. He pointed out that the equipment will serve not only as the subject for special courses, but also will be introduced briefly in many of the school's regular engineering and science courses.

The computer installation consists of a general purpose computer, using magnetic drum memory, housed in a single cabinet complete with power supply and all logical elements. The operator's console, which controls the computer, has an electric typewriter which controls and transmits information to the computer, printing out results of the computation.

By use of a magnetic tape unit, an additional memory storage is provided which is able to operate independently of the main computer memory, performing search operations and transmitting information by means of its own internal logical circuitry.

Ridgway Section Announces Engineering Scholarship Awards

The Vocational Guidance Committee of the Ridgway Section of AIEE recently gathered to congratulate the winners of the 1957 Elk County Engineering Scholarships. This year, the committee awarded, after competitive examinations were given, a scholarship of $1,200 for a four-year period to J. W. Smith of St. Marys Public High School, St. Marys, Pa., and an $800 scholarship for a four-year period to Robert Steger of St. Leo's Catholic High School, Ridgway, Pa.

Mr. Smith has enrolled at the Pennsylvania State University in the electrical engineering course of study. Mr. Steger has enrolled at the DuBois Undergraduate Center, Pennsylvania State University, in the engineering course.

The winners were chosen from 25 contestants selected from Elk County High Schools. These contestants participated in aptitude and psychological examinations which are given annually by the Vocational Guidance Committee.

At the meeting, it was learned that the winner of the first scholarship awarded five years ago, William Gallagher, graduated with top honors in chemical engineering from Pennsylvania State University.

Flight Test Engineering Fellowship Offered by IAS

The Institute of the Aeronautical Sciences (IAS) has announced competition is open for its Flight Test Engineering Fellowship at Princeton University.

Candidates must be United States citizens and have a bachelor's degree in engineering by June 1958. The graduate fellowship is open to anyone who meets these requirements—there are no other restrictive qualifications.

The Fellowship Award has a total value of $4,700. A first-year Fellow receives $1,500 as stipend and $600 tuiton. Second-year renewal, contigent upon satisfactory performance during the first year, brings with it a $2,000 stipend and another $600 tuition.

Winning candidates will join several U.S. Air Force and U.S. Navy test pilots in a special two-year program at Princeton providing a solid foundation of advanced technical training in flight test.

Application forms may be obtained by a request in writing, endorsed by a sponsor, addressed to Flght Test, Institute of the Aeronautical Sciences, 2 E. 64th St., New York 21, N.Y. Completed applications must be received before March 1, 1958.

Leading Teacher of Lighting Receives IES Gold Medal Award

Prof. J. O. Kraehenbuehl, the nation's most distinguished teacher of the science of lighting, recently received the Illuminating Engineering Society's (IES) highest honor, the Gold Medal Award.

The presentation was made by M. N. Waterman, president of the IES, at the opening session of the professional organization's annual national technical conference.

Prof. Kraehenbuehl, who is presently developing a pre-engineering curriculum at Colorado College, Colorado Springs, recently retired as professor emeritus in electrical engineering at the University of Illinois, Urbana, after 35 years as a faculty member of that institution. Previously, he taught electrical engineering at Des Moines (Iowa) College and mathematics at the University of Tennessee.

Professor Kraehenbuehl was chosen as medallist in recognition of "his far-reaching effect on the techniques of illumination in his long academic career, and his personal sacrifices in promoting the nation's general welfare through teaching the importance of scientific lighting."

MEMBERS of the Vocational Guidance Committee of the Ridgway Section and winners of the 1957 Elk County Engineering Scholarships are: *(left to right)* W. E. Yohe, committee chairman; C. E. Sassman, committee member; Robert Steger, scholarship winner; W. R. VanVranken, committee member; J. H. Schneider, committee member; J. W. Smith, scholarship winner; Leo Simbeck, committee member; and C. F. McGinnis, committee member.

Applications for Science Fellowships Invited by NSF

The National Science Foundation (NSF) has announced that applications are now being accepted in four NSF fellowship programs for advanced study and research in the natural sciences. The four fellowship programs are: (1) a predoctoral fellowship program for which college seniors and graduate science students may apply; (2) a postdoctoral fellowship program for scientists who have already received the doctoral degree; (3) a senior postdoctoral fellowship program for candidates who have held the science doctorate for a minimum of five years; and (4) a science faculty fellowship program for college teachers of science who wish to improve their competence as teachers.

Approximately 1,000 awards will be made in the NSF fellowship programs in March 1958. NSF fellowships are awarded to American citizens who have shown special aptitude in science and who will begin or continue their studies at the graduate or postdoctoral level. Under the broadened program fellowships will be awarded in the mathematical, physical, medical, biological, engineering, and other sciences, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and areas of convergence between the natural and social sciences.

Fellows will be selected on the basis of ability as evidenced by letters of recommendation, academic records, and other evidence of attainment. Applicants for the predoctoral fellowships are required to take the Graduate Record Examination. Candidates' qualifications will be evaluated by carefully chosen panels of scientists established by the National Academy of Sciences-National Research Council and the Association of American Colleges. Final selection of Fellows will be made by the NSF.

Stipends for NSF fellowships vary with the academic status of the Fellows. First year Fellows—students entering graduate school for the first time or those who have had less than one year of graduate study—will receive annual stipends of $1,600. Fellows who need one final academic year of training for the doctor's degree will receive annual stipends of $2,000. Fellows between these groups will receive stipends at the rate of $1,800 annually. The stipends for regular postdoctoral Fellows will be $3,800 per year. Dependency allowances will be made to all married Fellows. Tuition and laboratory fees and limited travel allowances will also be provided.

Senior postdoctoral Fellows and science faculty Fellows are awarded stipends adjusted to match as closely as feasible the regular salaries of the award recipients up to a maximum of $10,000 per year. A travel allowance is also usually made available.

NSF Fellows may attend any accredited nonprofit institution of higher education in the United States or similar institution abroad.

Applications for the 1958-1959 NSF graduate and regular postdoctoral fellowship program may be obtained from the Fellowship Office, National Academy of Sciences-National Research Council, 2101 Constitution Avenue, N. W., Washington 25, D. C. The closing dates for receipt of applications are December 23, 1957, for postdoctoral applicants, and January 3, 1958, for graduate students working towards advanced degrees in science. The selections will be announced on March 15, 1958.

Applications for the senior postdoctoral and the science faculty fellowships may be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C. Completed material must be received not later than January 13, 1958. Selections will be announced on March 18 and 20, 1958.

Engineering Careers Panel

A PANEL DISCUSSION on the topic, "Engineering Careers—Are High Schools and Colleges Preparing Students for Industry?" was conducted by the technical discussion group of Scranton Division, Lehigh Valley Section of the AIEE, at a meeting in the University of Scranton Science Building. Participants included: (left to right) R. P. Ehas, group chairman; Henry Landsman, panel moderator; and M. S. Merritt, Andrew Pionsky, and A. T. Jones, panel members.

Design Engineer Wins Marshall Scholarship

R. M. Dolby, young design engineer for Ampex Corporation, was congratulated by A. M. Poniatoff, board chairman, and G. I. Long, president, upon receiving a Marshall Scholarship. The distinguished award was made to Mr. Dolby in recognition of his outstanding record at Stanford University, from which he received this year the bachelor's degree in electrical engineering.

Marshall Scholarships are presented by the British Government in appreciation for Marshall Plan assistance to Great Britain after World War II. A maximum of 12 scholarships per year are awarded. These are divided geographically, so Mr. Dolby was one of only three chosen this year from all possible recipients in the Western United States, Alaska, and Hawaii. The Marshall Scholarship may be to any United Kingdom University and is unusual in providing allowance for family. Transportation to England and back is also given.

Mr. Dolby has chosen Pembroke College of Cambridge University, where he will be studying for what corresponds roughly to the U.S. master's degree known in England as "Part Two of the Tripos in Mechanical Sciences." The university is located about 50 miles north of London.

OF CURRENT INTEREST

ELEVATED temperature test facility installation can operate up to 2,500 F. Equipment includes ignitron power controller, lamps and reflectors, temperature sensing equipment, and a precision regulator to regulate time vs temperature or aerodynamic heating.

Test Facility Simulates Flight Through the "Thermal Barrier"

THE INTENSE HEATING of aircraft and missiles flashing through Earth's atmosphere at speeds above 5,000 miles per hour imposes structural design problems. At supersonic speeds, air vehicles must withstand temperatures above 2,500 F. To investigate and overcome structural limitations, the Westinghouse Electric Corporation has developed a complete elevated-temperature test facility.

The equipment consists of banks of tubular infrared lamps, three-channel ignitron controller, strip chart temperature recorders, regular control (computer) channels, master control desk, unit substation, and bus duct distribution.

A. C. Monteith (F '45), vice-president, apparatus products, said the test facility is designed to study the effect of high temperatures on structural parts of aircraft and missiles. The unit can create heat conditions encountered by missiles and aircraft at least three times faster than standard systems now in use.

The Westinghouse test facility—which can create 2,500 F temperature in 12 seconds—will enable aircraft builders and designers to pretest parts and aircraft in simulated flights through the heat barrier.

Structural and Aerodynamic Effects

Heating of the aircraft surface due to friction and compression of the air is related to the difference between the effective air temperature and the skin temperature of the vehicle. Under transient flight conditions, the temperature of the aircraft varies with time. Because heat flow is variable, the temperature distribution throughout the aircraft is uneven. This condition results in differential thermal stresses arising in the structure which are superimposed upon aerodynamic structural loads. An elevated-temperature test facility simulates all of these load effects in conjunction with the differential thermal stresses. The Westinghouse equipment is used to arrive at solutions of thermal transient distribution throughout different types of aircraft structures.

Infrared Lamps. Banks of quartz infrared lamps are used as the heating source. Each lamp is rated at 1,000 watts, 240 volts and is operated, in many cases, at 440 to 480 volts. These lamps operate satisfactorily at 600 volts and up to 900 volts, if necessary. In addition to the 10-inch, 1,000-watt, 240-volt nominal rating lamp, 2,500-watt, 480-volt, and 5,000-watt, 960-volt lamps are available. These lamps have an extremely rapid warm-up time.

Ignitron Control. The ignitron unit is designed to control the effective heating voltage impressed across a fast-response, variable-resistance load. This unit is an economical method of controlling the amount of heat delivered to missiles and aircraft. The ignitron control unit provides many advantages, such as:

1. Rapid response and a broad range of power control for a large number of infrared lamps.
2. Maximum safety of operation of equipment which is applied under conditions conducive to accidents to personnel and apparatus.
3. Either manual control or use with automatic regulator control. Sufficient gain is provided making the ignitron unit applicable to other types of regulating controls which may be developed.
4. Physically, the equipment is built as an independent cubicle which is easily and quickly moved from one location to another with only a reconnection of the incoming power line.
5. Power control characteristics are insensitive to the change in resistance of a load of lamps with change in temperature of the filament, or change in the number of lamps.

Two inverse-parallel ignitron tubes are connected in series with the load and act as valves to control the amount of power delivered. The cathode of one is connected to the anode of the other. The resultant output is an a-c current. The point in the cycle at which the thyratron energizes the ignitron tube determines the magnitude of the power delivered to the lamp, and thus the heating effect.

Ignitron control channels now operating are capable of carrying 800 amperes for five minutes. This current rating holds regardless of voltage. Thus, at 460 volts each channel delivers 360 kw. This corresponds to about 120 *T-3-1000* CL radiant lamps connected to a 460-volt channel. And, each channel operates adequately with one lamp connected to a channel.

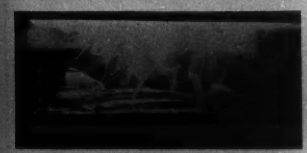
SINGLE BANK of quartz infrared lamps, in operation, are arranged (left) as a blanket a few inches away from structure to be tested to provide the desired heat pattern. Heat from each bank can be controlled separately. Model shown, just before bank of infrared lamps were switched on (left below), was used to demonstrate rapid rate of temperature increase possible on structures placed under infrared lamps.

0 seconds.

2 seconds.

3 seconds.

4 seconds.



5 seconds.

6 seconds.

This equipment has an extremely high short-time overload capacity. Current ratings of 3,000, 1,600, and 1,200 amperes at 3, 15, and 25 seconds respectively are achieved. Each short-time rating can be followed by a continuous rating of 300 amperes.

The response of the power control is rapid. For a change in control voltage the effective output voltage squared (heating effect into a constant resistance load) attains 63% of its final value in 0.02 seconds.

Temperature Recorder

A high-speed temperature recorder transcribes the temperatures of the control zones of the aircraft or missile under test. At present, the temperature recorder is calibrated for thermocouples in a temperature range from —350 F to +2,650 F. Chromel-alumel thermocouples used with this equipment are provided in three ranges; —350 to 650 F, 0 to 1,000 F, and —350 to 2,650 F. The temperature sensing and recording equipment incorporate special features to eliminate the high stray fields induced by the rapid power changes and unusual power wave form from the ignitron units.

Regulator Control

The regulator develops the control signal used to modulate the ignitron controller. This unit (computer) develops the signal either to regulate to a given time-temperature schedule required of the aircraft, or to a given power required signal as developed by arbitrary aerodynamic input functions and surface temperature measurement.

The power control responds to a signal which is proportional to the error between the power desired to be transfarred and the actual power transferred. Since no satisfactory heat transfer measuring equipment is known, two approximations are used. One takes the product of the voltage and current to obtain the power to the lamps; the other considers the heat per unit time into the aircraft as proportional to the derivative of the skin temperature.

The ventilated bus duct system consists of low-voltage drop plug-in busway using aluminum bus bars. The receptacles for plug-in devices are equipped with barriers to prevent live parts from being accessible at any time during installation or removal. Circuit breaker plug-ins prevent removal from the receptacle until the breaker is in the OFF position.

The bus duct requires a minimum of field measurements and installation time. Fittings are interchangeable and reusable. To provide for future additions or alterations, standard flexible fittings are available.

Safety Features

A thermal overload relay co-ordinated with the long thermal characteristics of the contactor and bus work, and an induction disc overload relay co-ordinated with the short-time characteristics of the ignitron tubes, permit full use of the equipment capacity. Both of these relays are arranged to trip the line contactor in case of equipment overload. Under these circumstances only one control channel is lost during a test run. Inasmuch as the shutdown is restricted to a small number of lamps, maximum test data are obtained.

In case of short circuit, the induction disc overload relay trips the ignitron feeder breaker. This short-circuit trip setting is fixed below the setting for the transformer breaker. For this reason, the feeder breaker trips off a small portion of the control circuits avoiding possible loss of all control channels. The flow of test data is uninterrupted.

Power for each channel is supplied by its own individual control transformer. No second source of power in any control channel section can cause personnel hazard while work is being done in an ignitron control cubicle.

Other safety features include extensive interlocking. For instance, door interlocks are provided to trip appropriate power supply controls when the door is opened. The door interlocks are connected with the channel ON-OFF push button located on the master control console. Therefore, the line contactors can never be energized when the doors are open.

Dynamometer Control Uses Electrically Simulated Inertia

Electrically simulated inertia has been substituted for unwieldy inertia discs (flywheels) in a new type of dynamometer control now available from General Electric's (GE) industry control department, Roanoke, Va.

The use of electrically simulated inertia eliminates the necessity for hoisting huge flywheels into place for the testing of acceleration and deceleration performance of passenger cars, trucks, and buses. Formerly, as many as 24 huge flywheels weighing a total of about 10 tons were required in the testing of heavy truck chassis. The flywheels were used to simulate the effect of vehicle mass.

Engineers say the new control provides savings in floor space, initial cost, and time required to set up for a test. Using electrical simulation, it is necessary only to set a potentiometer for the desired inertia value and put the test stand into operation, thereby eliminating the difficult and time-consuming task of setting up bulky flywheels prior to a test.

GE engineers say that several applications of electrically simulated inertia control are now being studied and indicate that wide usage of the new control is possible in the near future.

World-Wide Observations Gather Data in Co-operative IGY Program

UNITED STATES participation in the International Geophysical Year (IGY) program is planned and directed by the United States National Committee, which was organized by the National Academy of Sciences—National Research Council (NAS-NRC) and is under the chairmanship of Dr. Joseph Kaplan. A. H. Shapley, chief of the National Bureau of Standards (NBS) Sun–Earth Relationships Section, is vice-chairman of the U. S. National Committee, and one of the three American scientists that are members of the international committee (Comité Special Année Géophysique Internationale).

The NBS is playing an active, many-faceted role with observation stations widely scattered over the globe. It is collecting and analyzing data on many phases of upper atmospheric physics and radio propagation. Centered in the Boulder (Colo.) Laboratories, where most NBS radio propagation research is carried on, the Bureau's part in the program includes studies of the ionosphere, forward scatter propagation, various kinds of radio noise, airglow, and related phenomena. The results, when analyzed and correlated with those obtained elsewhere, are expected to provide valuable information in such fields as meterology and radio communications.

Ionospheric Studies

Because of its extensive studies of the ionosphere as a factor in radio propagation, the NBS has the responsibility for the ionospheric data program in the Western Hemisphere. In this program, information is collected from numerous laboratories making observations of the ionosphere and added to those obtained at the Boulder Laboratories. These data are available to research scientists in the Americas as well as to others at world data centers around the world.

At all times, the ionosphere is greatly affected by solar activity. At present, the 11-year sunspot cycle is entering a peak phase and, for the next year or so, the sun will be sending out gigantic flares of intense light from time to time thus affecting Earth's upper atmosphere with vastly increased barrages of ultraviolet radiation and streams of atomic particles. The results will be ionospheric disturbances with shortwave radio blackouts. In the high latitudes of the Northern and Southern Hemispheres, the ionosphere may even be expected to fail completely as a reflector of radio waves for several days at a time.

The NBS has had long years of experience in these activities and therefore has been charged with the task of equipping and supplying 19 new stations, carefully located to fill important gaps in the world network. Five of these—the Antarctic sounding stations—will be operated by NBS and the others will be closely guided in their work by NBS staff members. The pre-IGY network of 7 NBS-operated and 11 associated stations will continue throughout the IGY period. The NBS also plays an important role in the coordination of the international organization's program of ionospheric soundings.

In co-operation with several South American laboratories, the NBS is conducting the research into ionospheric forward scatter in the equatorial region. Seven stations have been set up near the equator for this purpose. Ionospheric scatter has been studied at arctic, subarctic, and temperate latitudes, but these are the first experiments carried out near the equator. The stations will transmit northward across Central and North America and eastward across South America. Further investigations will be made in the Caribbean area in co-operation with the U. S. Navy, and in the Far East in a co-operative program with the Voice of America and the Japanese Radio Research Laboratories.

Radio Noise Investigations

An important part in the IGY study will be the NBS role in radio noise observations. The objective here is to learn more about radio interference and propagation through the atmosphere and the ionosphere. Stations in 16 world-wide locations have been set up for noise observations in co-operation with other United States agencies as well as other countries. Byrd Station in the Antarctic is one of the American stations.

Results of these studies not only will provide valuable information about radio propagation and meterology, but also will establish an engineering basis for assigning frequencies to stations. Forecasts will be made of the amount of unwanted noise that will interfere with communication for the commercial and military radio users who must know which frequencies are best for use at a given time and place.

Near the Boulder Laboratory, the NBS has stretched a steel cable for 3,400 feet over a canyon, under 9,000 pounds tension. This cable will serve as a huge antenna to catch naturally occurring radio noises known as "whistlers" and the "dawn chorus." Whistlers are low-frequency signals initially generated by lightning discharges. The resulting radiowave is reflected back and forth between the Northern and Southern Hemisphere, following the earth's magnetic lines of force at heights up to 25,000 miles. The whistler radiowave is a mixture of tones that arrive at different times and create a descending whistle effect. Other radio noises that ascend in pitch, resembling the sound of small frogs have been given the name of dawn chorus.

Although a rocket can gather information about the ionosphere only up to about 250 miles, a study of whistlers gives clues as to the properties of space 100 times farther away from the earth. The NBS pioneered research on whistlers, and will operate 3 of the 26 stations gathering this data under the guidance of Stanford

Future Meetings of Other Societies

ASME, Annual Meeting, Dec 1-6, Statler and Sheraton-McAlpin Hotels, New York, N.Y., L. S. Dennegar, 29 W. 39 St., New York, N.Y.

Chemical Industries, 26th Exposition, Dec 2-6, New York Coliseum, New York, N.Y., E. K. Stevens, 480 Lexington Ave., New York, N.Y.

Human Factors Society-IRE, joint symposium on "Human Factors in Systems Engineering," Dec 3-4, Penn-Sherwood Hotel, Philadelphia, Pa., J. A. Howells, General Electric Co., MOSD, Philadelphia, Pa.

Industrial Education Institute, W. J. Cahners, 25 Huntington Ave., Boston, Mass.

How To Develop Your Own Public Relations Program, Dec 3, Cleveland, Ohio

Predicting Profits from New Equipment and Facilities, Dec 3, New York, N.Y.

Simplified Drafting Practices, Dec 3, Pittsburgh, Pa.

Pretesting Variables in Experimental Design, Dec 4, New York, N.Y.

Advanced Techniques in Functional Drafting, Dec 4, Philadelphia, Pa.

Solving Industrial Problems through Creative Thinking, Dec 5, Cleveland, Ohio

Simplified Drafting Practices, Dec 5, Toronto, Ont., Canada

Clear Technical Writing, Dec 10, Philadelphia, Pa.

AIME, Electric Furnace Steel Conference, Dec 4-6, Penn-Sheraton Hotel, Pittsburgh, Pa., H. N. Appleton, 29 W. 39 St., New York, N.Y.

Industrial Engineering Conference, sponsored by Illinois Institute of Technology, Dec 5-6, IIT Campus, Chicago, Ill., V. J. Danilov, IIT, 35 W. 33 St., Chicago, Ill.

AIChE, Annual Meeting, Dec 8-11, Conrad Hilton Hotel, Chicago, Ill., F. J. Van Antwerpen, 25 W. 45 St., New York, N.Y.

Fluorides Symposium, Institute of Industrial Health, Dec 9-11, College of Medicine, University of Cincinnati, Cincinnati, Ohio, Secretary, I. I. H., Kettering Laboratory, Eden & Bethesda Avenues, Cincinnati, Ohio

Institute of Human Communication, seminar, "Making Employee Benefits Count," Dec 9-11, Harvard Club, 27 W. 44 St., New York, N.Y., W. B. Harrison, IHC, Dover Plains, N.Y.

NACE-University of Illinois, Cathodic Protection Short Course, Dec 9-13, University of Illinois, Urbana, Ill., A. B. Campbell, NACE, 1061 M & M Bldg., Houston, Texas

Franklin Institute, symposium on "Airways Modernization Board: Its Mission and Methods," Dec. 16-18, Hotel Sheraton, Philadelphia, Pa. Ed. Nelson, Franklin Institute, Philadelphia, Pa.

ASHACE, Annual Meeting, Jan 27-29, Pittsburgh, Pa.

Plant Maintenance and Engineering, 1957 Show, Jan 27-30, International Amphitheatre, Chicago, Ill., Clapp & Poliak, Inc., 341 Madison Ave., New York, N.Y.

Engineering and Management, 1958 Course, Jan 27-Feb 6, College of Engineering, Graduate School of Business Administration, University of California, Los Angeles Campus, Los Angeles, Calif., E. P. Coleman, Co-ordinator, E & M Course, C of E, University of California, Los Angeles, Calif.

SPE, 14th ANTEC "Progress through Plastics Engineering," Jan 28-31, Sheraton-Cadillac Hotel, Detroit, Mich., C. H. Whitlock, C. H. Whitlock Associates, 21655 Coolidge Hwy., Oak Park, Mich.

ASEE, 1958 College-Industry Conference, Jan 30-31, University of Michigan, College of Engineering, Ann Arbor, Mich., Relations with Industry Division, ASEE, 255 West Engineering Bldg., Ann Arbor, Mich.

THE CONTROL ROOM (below) of the IGY World Warning Agency where radio signals are monitored and teletypewriter messages are received from and sent to all parts of the world. Drawing (above) which illustrates the production of whistlers, a special kind of natural radio signal in the audio and very low frequency range. Radio telescope (left), one of a pair near Boulder which will be focused for close listening on the sun. Information will be fed to the World Warning Agency at Fort Belvoir.

National Bureau of Standards Photos

University and Dartmouth College, the United States' co-ordinators in this endeavor.

Data Processing

The Boulder Laboratories will serve as the data processing center for analyzing and measuring airglow records supplied by the American chain of observing stations (*Electrical Engineering*, March 1957, pp. 252-53). For purposes of comparison, data will also be sent in from a station in another longitude—at Sydney, Australia. Results from these stations will be correlated with those obtained by other countries.

Focal point of the day-to-day co-ordination of a large part of the IGY observations, accomplished through the most extensive communication network ever arranged for scientific research purposes, is the NBS radio forecasting center near Washington, D. C., which was selected as the IGY World Warning Agency by the International IGY Committee. From this nerve center located at Fort Belvoir, Va., warnings are flashed to scientists throughout the world to redouble their observational efforts in anticipation of unusual activity in cosmic rays, aurora, earth magnetism, and ionospheric disturbances.

Much of this program will be greatly aided by modern high-speed techniques developed chiefly during the past 10 years (*Electrical Engineering*, September 1957, p. 825). Without them, scientists could scarcely hope to keep up with the processing of the billions of geophysical measurements to be recorded during the IGY period.

Volunteer Radio Tracking

Program Moonbeam designed for volunteer radio tracking of the scientific earth satellite was announced recently by the IGY Committee of the NAS–NRC. The program will provide organized technical assistance to amateur radio groups for the operation of simplified tracking systems during IGY. These systems will enable volunteers to locate the satellite in its flight and to receive scientific data transmitted from it (*Electrical Engineering*, October 1957, pp. 935-36). The Naval Research Laboratory is to head the Moonbeam project, with the assistance of the Jet Propulsion Laboratory of the California Institute of Technology. The American Radio Relay League will give active support to the program, too.

Antarctic Developments

A briefing for IGY scientists who departed for the Antarctic was held at the United States Naval Construction Battalion Center, Davisville, R. I., on September 16-20. It prepared them to relieve other scientists who have spent the past year doing research at United States scientific stations set up in the Antarctic for the IGY. Of the 100 scientific personnel who will participate in the program, 70 will spend the next 18 months at widely scattered Antarctic stations, and so do not have another opportunity to meet as a group to discuss their research programs. These men were selected by the IGY

Committee for Antarctica work from an extensive list of candidates submitted by many public and private research institutes. They underwent extensive and rigorous examinations to determine their suitability, both physically and professionally, for the difficult Antarctic scientific program, which is designed to fill an important gap in our knowledge of global weather patterns, to improve our understanding of upper atmospheric phenomena that substantially affect communications and navigation systems, and to add to our knowledge of ice, water, and heat relationships on Earth (*Electrical Engineering*, August 1957, pp. 749-50). Among the techniques used are shipboard rocketry programs, oversnow traverses, and the scientific investigation of deep ice crevasses.

A deep snow pit dug for scientific purposes at the Amundsen-Scott IGY South Pole Station reached a depth of 50 feet on October 1, according to reports which have been received by the IGY Committee. The pit, which was dug by hand throughout the long Antarctic winter, serves a dual purpose. The successive layers of snow laid bare form an unspoiled record of climatic and other history. The snow itself is melted for a water supply.

Snow in the pit is so hard that even saws cannot be used. The snow must be chipped loose with mattocks or ice axes and then shoveled into bags and hauled to the surface. Each man at the station spends a minimum of two hours every week either cutting or hauling the snow, despite the rapid onset of fatigue in the subzero temperatures. An 18° ramp is maintained to provide access to the pit.

Reports from the Amundsen-Scott Station state that the temperature in the pit is nearly constant at —60 F, whereas at the surface a record temperature reading of —102.1 F was recorded on September 17. During the period from May 11 through September 17, South Pole temperatures were lower than —95 F on 17 different occasions.

A careful study of snow stratification, combined with examination of snow crystals and density, yields a history of the Antarctic. Minute traces of ash may indicate an earthquake many hundreds of years ago. Pollen deposits provide a clue to past wind systems.

Measurements are being made to determine whether the Antarctic ice sheet is experiencing an annual gain or loss of thermal energy. This part of the work involves measurements of the temperature profile, heat capacity, and thermal conductivity of the ice with depth.

Satellite Tracked

The U.S. Army has announced that its newest high-power direction finder has been brought to bear on the Soviet satellite, assisting in tracking its orbit as far as half way around the globe.

The high precision radio sentinel at the U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., is one of the more recent additions to the military electronics arsenal and is capable of pinpointing signals in any part of the earth—and far out into space.

Since the station was alerted a few hours after the satellite's launching, the Army's new equipment, operating around the clock, has sighted and followed the sphere by radio almost every time it circled the earth. Once the electronic eye of the detector showed an error had been made in predicting the satellite's orbit by other means. The corrected path was placed south instead of north as calculated earlier.

At 11:37 p.m., October 6, the indicators of the Army's electronic finder showed the Soviet's space vehicle passed almost directly over the Fort Monmouth site.

In operation, the high-precision equipment, designed to pinpoint enemy radios in combat, continuously scans the skies for the satellite's faint radio beep. Immediately on contact, a propeller-like pattern flashes on the electronic viewing screen to give operators a direct and continuous angular bearing on the sphere.

At the same time the Army Signal Corp's latest high-power combat receivers were in operation and picked up the satellite's signal during 50 consecutive revolutions, intercepting it both directly and via the long path around the world, spanning a distance up to 24,000 miles.

The Army's combat intercept equipment is believed to be the most sensitive automatic direction finder yet developed, particularly for the vital 40-mc frequency which in recent orbits has shown more reliability than that of the lower 20-mc frequency.

Army soldier–scientists on a desolate ice island near the North Pole have reported what is believed to be the longest continuous contact with the Soviet earth satellite.

Their radio monitored the sphere for more than 13 hours on successive days as the sphere circled the earth.

At other spots throughout the world, the satellite's radio signal can ordinarily be picked up only for about a half hour at a time as the space vehicle passes nearby. At this writing, the signals have ceased and a bigger one put on orbit.

The soldiers were on Fletcher's Ice Island—a 10-mile long fragment of shelf ice in the Arctic Ocean—to make special studies of communications near the Pole for the U. S. Army Signal Radio Propagation Agency at Fort Monmouth, N. J. Their valuable satellite readings have been relayed to IGY Vanguard Headquarters through the Signal Engineering Laboratories.

Scientists credit the outpost's unique position—about 450 miles from the North Pole—for the greatly extended reception. The satellite's radio signal, they reason, must have come down from space and ricocheted several times between the earth's surface and the under side of the ionosphere like a pool ball between two opposite cushions.

There are few spots in the world where such "ducting" could have occurred to bring the signal in consistently.

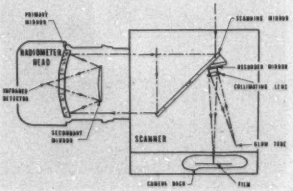
Since the station went on the air, it has received the satellite's signal almost continuously, even when it was barely perceptible in the U. S. The outpost reported two other continuous monitorings of 7 and 10 hours.

Thermal Camera Utilizes Infrared Radiations

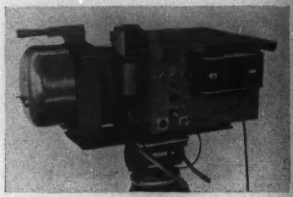
A REVOLUTIONARY new technique for taking "heat pictures" was unveiled by Dr. R. B. Barnes called the Far Infrared Camera to take heat pictures, or thermal photographs, by photographing the infrared radiation or heat given off by objects. Heat pictures differ from conventional photographs which use the visible light reflected by all objects. The camera detects the infrared radiation and converts it into black-and-white photographs. Each point on the photographic image indicates the heat being emitted by that point and can be converted into temperature readings.

The new camera is an extremely refined instrument, designed to give a quantitative photographic record of the temperature distribution of the objects pictured. Hence, the heat pictures taken with it can be used in making heat measurements. Special film is not required, because the image is formed by means of an ordinary light beam inside the camera.

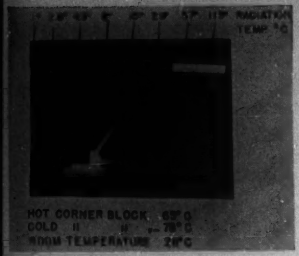
In this manner, the objects pictured in the photographs are clearly recognizable:



SCHEMATIC DIAGRAM details exact nature of the scanning system that is incorporated in the Far Infrared Camera used in accompanying pictures.



FAR INFRARED CAMERA showing radiometer with telescopic sight, scanning mechanism, and Polaroid Land Camera for recording results.



ONE CORNER of metal triangle is set on hot plate while other rests on block of dry ice. Temperatures along metal are easily compared with gray scale. Upper corner of triangle is at room temperature.

however, their black-and-white shading is based on the graduations of emitted heat intensity rather than reflected light.

The complete camera consists of an 8-inch Optitherm Radiometer system, devised by the company, for measuring the infrared radiation; a scanning attachment; and a visual camera to record the image. The entire assembly weighs about 100 pounds.

In operation, the camera is sighted on the object to be photographed. Although, apparently, it is motionless during an exposure, an internal mirror scans back and forth across the field of view for several minutes. An ultrasensitive, fast heat detector in the radiometer picks up the radiation emitted by various points of the object. This modulates a light beam. The more intense the radiation detected, the brighter the beam. The object or scene being photographed is scanned from top to bottom and side to side just as the image on a television screen. The modulated light beam is simultaneously scanned over the film in the corresponding pattern. The final black-and-white picture is made up of a series of closely spaced lines. The light areas on the picture correspond to areas in the object emitting the most heat; dark areas mean less heat. Scanning time for a picture depends on the sensitivity and detail required; it may be as brief as 2 minutes or as long as 15 minutes.

Sensitivity of the camera is very high. It can detect temperature differences as small as 0.02 C. Dr. Barnes displayed photographs of a person in which the blood vessels could be picked out readily from the surrounding skin area.

This type of thermal photography, incidentally, is not the same as the "snooperscope" of World War II fame.

The Far Infrared Camera also differs from other infrared scanning devices such as those used in infrared aerial reconnaissance. This camera gives an absolute quantitative record of the emitted heat, permitting detailed analysis of surface temperature distributions, which is not possible with other infrared scanning or imaging devices.

Perhaps the widest application for thermal photography falls within the field of scanning industrial equipment and processes. A heat picture of a refinery, for example, will show readily where hot spots—potential sources of trouble—may be developing. Similarly, a picture of a bank of electric switches can reveal overheating of elements in the switches that

ELECTRONIC CHASSIS temperature distribution shows tubes clearly outlined as well as glowing pilot lights at left. Gray-scale steps range from 284 F (white) to 68.0 F (black).

HEAT BUILD-UP is clearly seen in resistors of the same chassis seen from bottom. Potential trouble spots are comparable with gray scale of 194 F (white) to 64.4 F (black).

BANK OF SIX electric switches in black-and-white photograph appear normal to the eye and seem to be in good operating order. Infrared photo shows that three of the switches were overloaded by about 150%.

ELECTRIC SWITCHES in infrared picture are revealed to have three switches at higher temperature than others, and one switch slightly higher. Gray-scale values are 230 F (white) to 64.4 F (black).

Formula for Scanning Rate

$S = 90\,(\Delta F)\Omega$

Where S = Scanning rate in square degrees imaged per minute
ΔF = Radiometer signal bandwidth in cps
Ω = Solid angular field of view of radiometer in square degrees.

Typical Scanning Time of 100 square-degree field (10° x 10° or 20° x 5°) with 1 x 1 milliradian element

Radiometer Bandwidth cps	S Square Degrees per minute	Scanning Time Minutes	N.E.T. 8-inch Radiometer	
			Unimmersed Thermistor Detector	Immersed Thermistor Detector
20	5.9	17	0.08°C	0.02°C
50	14.8	6.8	0.2°	0.05°
100	29.6	3.4	0.6°	0.15°
180	53.3	1.9	1.5°	0.36°

BLACK-AND-WHITE picture of powerhouse shows windows ablaze with light, chimneys silhouetted against the sky. Gray scale in infrared photo ranges from 113 F (white) to 78.8 F (black).

INFRARED photograph shows actual temperature range of powerhouse. Smokestacks are bright because of high heat, lighted windows are black inasmuch as infrared does not penetrate glass.

PIPE BOWL is hotter than 133 F (white) of gray scale, cooling to room temperature near mouth. Mouth, chin, and throat are warmest; ear edges, finger tips, hair, and glasses are coolest. Low step of gray scale is 75.2 F.

might be due to overloading or poor switch contacts.

An analytical approach to scanning time requirements first requires consideration of the number of resolution elements in a particular field of view.

The selected over-all field of view also affects scanning time. Two different fields of view combinations are available in the standard scanning attachments. One combination has a fixed horizontal field of 20° with a 10° or 5° vertical field selectable by means of a switch. The other arrangement has a fixed horizontal field of 10° with a 10° or 5° vertical field under the control of a selector switch. In either combination the total scanning time for the 10° vertical field is twice as much as for the 5° vertical field. In addition, using a 20° horizontal field requires twice as much scanning time as for a 10° horizontal field when identical vertical fields are used.

System bandwidth is necessarily limited by consideration of detector response time and the maximum tolerable system noise, to which the major contributing factor is detector Johnson noise. Inasmuch as this noise limits the smallest detector output signal which can be seen in the final image, it thus limits the ability of the system to detect small temperature differences. This limiting ability of the system is expressed by the Noise Equivalent Temperature (N.E.T.) specification, and is defined as the black body temperature difference over the entire field of view (at 25 C) which is equal to rms noise. Consequently, for any given detector, faster scanning speeds can be utilized if the system bandwidth is increased, but this increases noise and thus lowers the sensitivity. On the other hand, the use of slower scanning speeds and narrow system bandwidth brings about an increase in system sensitivity at the expense of scanning speed.

However, there is a method by which bandwidth, and consequently the scanning speed, may be increased without sacrifice of noise equivalent temperature. This can be done by exchanging the standard thermistor detector for an equivalent germanium-immersed thermistor which has increased detectivity without increase in inherent noise. For example, the 8-inch radiometer with a standard 1-mil by 1-mil detector and a 10-cps bandwidth has a noise equivalent temperature of 0.1 C. If an immersed detector with the same field of view is installed in the radiometer, a 50-cps bandwidth may be used with no change in the noise equivalent temperature—thus permitting a scanning speed increase of 5 times.

An experimental setup was designed to illustrate the temperature gradients when heat is conducted between a hot and cold object. Three metal bars were attached together to form a triangle. The bars were sprayed with black paint to form a surface of high emissivity. One corner of the triangle was placed on a hot plate and another corner was placed on a container of dry ice. The radiance corresponding to the gray-scale steps are computed from the radiometer gain setting, and reference black body temperature. The gray-scale steps are set up to give approximately equal density steps. This gives a logarithmic radiance scale which is why the steps become progressively larger toward the bright end. The temperature corresponding to the gray-scale steps are also given assuming black body radiation.

The temperature of the block on the hot plate was measured with a surface thermometer at +65 C and room temperature was +26 C. Visual comparison of these points on the picture with the gray scale checks the measured temperatures. Greater accuracy could, of course, be attained with more gray-scale steps or a densitometer. Black in this picture corresponds to a black body temperature of +10 C. All objects below this radiance level will also appear black; therefore, the dry ice temperature cannot be checked. The gradient in the bars passes through room temperature when they blend into the same tone as the background.

It is important to realize that the great utility of thermal photography—and infrared detection in general—lies in its ability to detect and measure relatively low temperatures. There are many ways of detecting and measuring objects at high temperatures, once they have reached red heat, but not so for "cool" objects—those below 1,000 F. It is with objects below 1,000 F—those that give no visual manifestation of heat—that thermal photography, and infrared radiation measurement is most useful.

The success of the infrared camera is based upon a rugged and sensitive heat detector called a thermistor bolometer, a device no larger than a quarter. These detectors contain thin flakes of oxide semiconductors. When these flakes are struck by infrared radiation, their electrical resistance changes. By measuring these electrical changes, it is possible to detect the minute changes that take place in heat radiation in as short a time as 1/1,000 of a second.

The principles of the infrared camera are being applied to air collision warning devices. The camera itself is ideal for measuring the infrared radiation emitted by aircraft caused by engine heat, and can thus be used to measure the infrared radiation passively emitted by all aircraft.

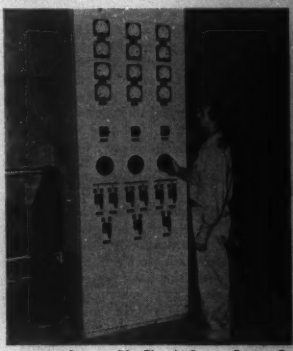
Ray Proof Corporation Photo

WELDED JOINTS in missile air frames are radiographically inspected in this specially designed building.

News of Recent Nuclear Developments

Economic Civilian Nuclear Power. The Organic Moderated Reactor Experiment (OMRE) developed for the Atomic Energy Commission (AEC) by Atomics International, a Division of North American Aviation, Inc., has been placed in operation at the AEC National Reactor Testing Station in Idaho.

Operation of the reactor, a new type which is part of a program of the AEC for the development of economic nuclear power for civilian use, began when self-sustaining nuclear fission was achieved on September 17, 1957. The OMRE is the first nuclear reactor of this type to go into operation.



Courtesy The Electric Storage Battery Co.

CHARGING of Exide-Manchex storage batteries (60-*EMP*-17 and 60-*FME*-17) at world's first full-scale atomic-powered generating station at Shippingport, Pa., is regulated from this panel.

Westinghouse Photo

FUEL CHARGE in first full-scale atomic power plant in the United States was this 58-ton multimillion dollar nuclear core which is lowered slowly into position with its precious fuel consisting of 14 tons of natural uranium and 165 pounds of highly enriched uranium.

It uses an organic fluid, a carbon-hydrogen compound called terphenyl, for the dual role of moderator–coolant. As a moderator, the material slows down neutrons produced in the atomic fission process, helping to sustain the chain reaction. As a coolant, it circulates through the reactor core where it absorbs the heat from the fission process, which it then carries to heat exchangers.

About 16,000 kw of heat will be produced when full power is attained. Present plans do not call for the conversion of the heat into electricity.

Overseas Markets for Atomic Industry. The emergence of a prospective world market for atomic energy equipment and services has been underscored in the annual report of the Atomic Industrial Forum (AIF) as an important source of the economic incentive that the atomic industry now needs and lacks.

Forum President Alfred Iddles said in a letter to AIF members that roadblocks facing industry, whether technical or economic, political or social, suggest the need for understanding and co-operation between Government and industry.

The prospective market abroad appears primarily to be in Western Europe, which has had the occasion to feel with special acuteness the finite limits, as well as the uncertainties, of its own supplies of fossil fuels on which its economies depend. Through their common organization, the Organization for European Economic Cooperation, and Euratom, western European countries have begun to lay cooperative plans for research and development for joint facilities and programs looking toward large-scale application of nuclear power.

Another example of the developing world market, cited in the AIF report, is Japan, the most highly industrialized nation in Asia which, because of her meager resources of fuel, is planning an atomic power program of at least 1 million kw by 1965.

The report noted that these developments and others in Latin America and in Western Europe are beginning to make themselves felt in the United States and other nations in the form of initial contracts for the design and manufacture of nuclear power equipment, and in discussions and negotiations which indicate a large volume of orders which may be expected to follow.

In the United States, the report emphasized that industry has scored impressive achievements and that the past year has seen announcements of several major nuclear power reactor projects and the actual start of construction on the first generation of industry-owned central station nuclear power plants. In addition, the industrial use of radioisotopes has continued to increase steadily, with annual savings from isotopes use now estimated to be on the order of $500 million.

Economic problems in the United States will be solved by advancing technology, but the reappraisal now in progress already has shown that a truly profitable atomic enterprise in the United States is in the future and will require more effort to achieve than had been first estimated.

It is naturally in the interest of the public for as broad an industrial base as possible for the United States' atomic energy enterprise to be established. But it is also clear that the sooner a profitable situation is realized, the healthier and sounder will be the base of the atomic industry, both here and abroad in future years.

Specially Designed Building Shields Against X-Rays. One of the first buildings specifically designed for the radiographic inspection of guided missile air frames has been completed for Reynolds Metals Company at its parts division plant in Sheffield, Ala. The building provides complete protection against scatter radiation effects of a 250-kv General Electric Company (GE) X-ray machine. Ray Proof Corporation, Stamford, Conn., designed the building and was responsible for the design and construction of all radiation shielding devices employed in the structure. Prime purpose of the inspection is to check the soundness of welded joints in the air frame.

The inspection room is adjacent to the final missile assembly area and is isolated from that area by heavily shielded doors weighing 5,000 pounds. Missiles to be tested are wheeled through these motorized doors when they are to be inspected. Lead shielding in the doors prevents the escape of radiation. Lead-lined wooden panels on one side of the structure protect the dark room and the control room. An extra precautionary feature of the shielding plan is the positioning of a wire fence which surrounds the building. It is so located as to keep passers-by well out of the way of potentially harmful radiation.

The building has a brick exterior and concrete slab interior. It is 30 feet wide, 53 feet long and 17 feet high. The X-ray unit is mounted on a pantographic support and suspended from overhead crane rails.

Batteries To Control Atomic Electric Generator. An Exide-Manchex battery will power the vital control circuits on the starter of the world's first full-scale atomic power plant generating electricity exclusively for civilian needs.

Not only will the industrial type batteries actuate the world's most critical starter, they will control the atomic generator's operation and apply power brakes to shut down nuclear fission.

The Electric Storage Battery Company, Philadelphia, Pa., has built the three 60-cell Exide-Manchex batteries, a type widely used in industry, which have been installed at the atomic power plant in Shippingport, Pa.

One of the three big Exides is vital to the operation of the control mechanism of the Shippingport reactor, heat source for the steam that operates the generator.

The second Exide-Manchex is one of three basic power sources—battery, diesel generator, and 2,300-volt line—for the turbine and generator phases of the plant's operation.

The third storage battery supplies emergency lighting throughout the reactor and generating plant buildings.

On signal from a central control console, power from *60-EMP-13* battery rotates a mechanical d-c to a-c low-frequency inverter. This permits power from motor–generators to be fed to low-frequency a-c synchronous reluctance motors. These motors rotate the armatures of the rod-drive mechanisms, forcing rotating roller nuts against lead screws connected to the control rods. This raises the control rods vertically at rates up to 20 inches per minute.

When the plant is operating, the power level of the reactor is regulated by the movement of the control rods. Other battery-operated components also are essential to the plant operation, such as: (1) over-temperature warning device on rod-control motor–generators, (2) vital instruments for measuring and controlling temperature and flow of the coolant, (3) circuit to maintain proper coolant pressure, and (4) instrumentation to annunciate all vital circuits. The major portion of this vital rod programming is accomplished by using a control circuit operated by the reactor-control battery.

For large load reductions, the Exide-Manchex battery operates the controlled steam relief system equipment to dump secondary steam. This reduces the steam load in gradual steps.

Under normal conditions, it is a relatively simple matter to cut back reactor output for a plant shutdown. Actually, the reactor never is shut off completely. It is reduced to a minimum neutron-producing level. To do this, the battery-operated control circuits give the impulse for shutdown, and the synchronous reluctance motors insert the control rods into the reactor core.

The Shippingport plant also is equipped to cope with extraordinary circumstances which might necessitate a fast reactor shutdown—called scramming. In the event of any failure in the plant, in any significant component or of any equipment which could cause the release of radioactivity, the reactor would be shut down immediately. Constant control is used in a policy of maintaining super safety.

Under emergency conditions the *60-EMP-13* reactor battery is expected to deliver 55.8 amperes for 1 full minute, followed immediately by 40.8 amperes for 30 minutes, then 14.9 amperes for 7½ hours. This sequence is followed by a load of 120 amperes for 1 ininute. These loads represent maximum conditions. The Exide-Manchex batteries must supply them down to a final voltage of 1.75 volts per cell.

Emergency lighting throughout the reactor and generating plant buildings is provided by a *60-FME-17* battery. The 20-kw load includes lamps at all critical control and operational points, as well as at exits.

Each of the three batteries is charged by means of a separate motor-generator set. A specially designed battery-charging control panel is located near the main plant control console.

Core Installed in Shippingport. Engineers and technicians of Duquesne Light Company and Bettis Atomic Power Division of Westinghouse Electric Corporation recently lowered the nuclear core, or charge of fuel, into position in the nation's first full-scale atomic electric gen-

erating station, an important and historic step toward completion of the world's first full-scale atomic power station devoted exclusively to serve civilian needs.

It is within this core that the "hot" nuclear reaction, or fission process, will take place. The nuclear furnace will heat high-pressure water which then will turn a second supply of water into steam. The steam in turn, as in a conventional coal-fired electric generating station, will produce electricity to serve the Pittsburgh, Pa., area industry and homes.

Atomic power scientists and technicians closely supervised the maneuvering of the 58-ton core as it moved with only 0.06-inch clearance between walls of the stainless steel pressure vessel. The interior of the vessel, which stands 33 feet high and has an inside diameter of 9 feet, is lined with ¼ inch thick stainless steel that provides maximum corrosion resistance.

The core for the pressurized water type reactor is only 6 feet long and is more than 6 feet in diameter. There are 32 "seed" fuel elements and 113 natural uranium elements in the core.

Extremely pure water, which serves both as moderator and coolant, will flow at the rate of 18,000 gallons per minute through each of four main coolant loops in the plant to produce the 60,000-kw minimum power. The water pressure will be at 2,000 psi with an average temperature of about 525 F.

The entire nuclear portion of the power plant is housed in four steel containers which, in turn, are in concrete compartments partially below the ground level. Over-all control of the plant is from a single control center.

Custom Production of Radioisotopes. The first nuclear reactor designed for the custom production of radioisotopes, as well as training and research, will be built by General Atomic Division of General Dynamics Corporation at its John Jay Hopkins Laboratory for Pure and Applied Science, San Diego, Calif., it was announced recently.

Called the TRIGA, this multipurpose reactor will have facilities for practical training in reactor operation and for reactor research in chemistry, physics, metallurgy, biology, and medicine. It is one of three reactor types being developed that will utilize the new, inherently safe, solid homogeneous reactor core presently undergoing critical assembly testing at the General Atomic Laboratory site on Torrey Pines Mesa.

The other two new reactor types now under design that will use the new core are a versatile research reactor, REGA *10-30*, and IRGA, a version of TRIGA that is designed for the industrial production of radioisotopes. IRGA will not require a trained operating staff.

The isotope-producing reactor, IRGA, will operate at a power level of 10 kw. It will be particularly useful for the production of short-lived isotopes, those with half-lives of less than 12 hours. These short-lived isotopes presently are not readily available to those many organizations distant from a production center such as Oak Ridge National Laboratory. The inexpensive, on-site availability of such short-lived isotopes will greatly expand their application to industrial process control as well as research.

TRIGA, the training, research, and isotope-production version of IRGA, has all the isotope-production facilities of IRGA. In addition, it has more reactor controls which may be used by students to learn reactor characteristics, including transient behavior.

In the center of TRIGA's core there is a one-inch diameter "glory hole." This opening in the core permits students to experiment on reactor design.

Both IRGA and TIRGA can be constructed in pits that measure 20 feet deep by 6 feet in diameter or in other configurations depending on construction and operating conditions. Shielding above the core allows students being trained in reactor operation to observe the core while the reactor is operating.

The research reactor REGA *10-30*, is designed for research in many fields of physical and biological science and engineering. Built on ground-level and shielded by concrete, the reactor can be operated continuously at 10 kw.

Nuclear-Powered Unlimited-Range Air Transport. A large nuclear-powered air transport with virtually unlimited range is practical and can be built. R. W. Middlewood, chief engineer of Lockheed Aircraft's Georgia Division, Marietta, Ga., presented a technical paper coauthored by R. B. Ormsby, Jr., supporting this assertion at the National Aeronautic Meeting of the Society of Automotive Engineers (SAE).

The nuclear-propelled airlift giant will not be dependent on large (and inexpensive) overseas stocks of chemical fuel for military operations. For example, a fleet of nuclear transports could move a U. S. Army division from San Francisco, Calif., to Manila, Philippines, nonstop, land or paradrop the cargo in the Philippines, and return nonstop to the United States, all without the need for intermediate bases or the necessity of a supply of fuel anywhere outside the continental United States. The round-trip nonstop range of a nuclear transport to any point on the globe would add a tremendous new military advantage for this nation.

Using conventional cargo airplanes for long-range military airlift currently requires two major logistic operations: (1) an air-transport system carrying the military cargo, and (2) a supply and support system on sea or land, or both, to carry fuel to the aircraft and service them when and where needed. A major superiority of nuclear transports is elimination of the need for the supplementary supply system outside the borders of the nation.

A large transport airplane using a nuclear reactor as an energy source can be successfully designed to carry a "logistical payload" of 50 tons or more for a distance of 24,000 miles or more, it was stated.

Design features of the successful nuclear-powered logistic transport would include: (1) easy loadability, (2) ability to utilize existing airfields. (3) capability of carrying all types of cargo, (4) no requirement for extensive ground handling facilities, and (5) no requirement for large numbers of crews.

The nuclear-powered logistic transport would most likely be a propjet—like the Lockheed *C-130* Hercules—according to the engineers. This prediction is based on the fact that a given amount of energy released from a reactor, if utilized in a propjet engine, will produce over three times as much thrust for takeoff as it will in a turbojet engine.

Considerable emphasis has been put by the Air Force on building up air transport for deploying military forces, and the propjet *C130* Hercules, now in quantity production, is the new-type airplane being used in this build-up of combat air transport capability.

Appearance of a nuclear-powered transport would greatly resemble the current *C-130* combat transport, the SAE was told. It will most probably have one reactor as the basic power source, although there is some possibility of two reactors. Shielding around the reactor or reactors will probably be on the "divided" principle, in order to reduce weight. This means some of the shielding will be around the reactor and other shielding will be around the crew compartment or other radiation sensitive areas—thus "dividing" the shields, instead of putting all the shielding around the reactor, which is the source of the radiation.

Weight of the nuclear fuel in the plane will be "insignificant" in designing an efficient airlift vehicle, but the weight of the shielding will be one of the chief design problems.

Missile Tests and Records Set

Disclosure was made recently that high velocity shock waves which reached speeds of more than 100,000 mph as they flash along a specially designed shock tube are being achieved by Lockheed Missile Systems Division scientists.

These fantastic velocities, well above Mach 150, are among the fastest ever

X-7 RAMJET missile has successfully completed its 10th flight—a record for such vehicles. Before making a parachute and nose spike landing, the X-7 set three new speed records.

reached under controlled laboratory conditions. The swiftly-moving shock waves, which also produce temperatures higher than 100,000 C, are created in an advanced hydromagnetic shock tube built by Lockheed's missile scientists at the division's research and development center in Palo Alto, Calif. New shock tubes now being designed should provide considerably higher velocities and temperatures. This significant research program is providing valuable data on the flow of highly ionized gases at extreme Mach numbers and temperatures.

To obtain the velocity and temperature measurements, new techniques involving photoelectric, spectroscopic, and microwave systems have been developed.

Aside from their own intrinsic interest, these studies should provide information on the properties of superheated gases of importance to the science of hypersonic ballistic missiles. It is expected that some of the results will have application to outer space travel.

With this project the Lockheed scientists, one of the few groups in the nation working in magnetohydrodynamics (a new science field which studies how magnetic fields influence and are influenced by ionized gases), are investigating the interaction of highly ionized gases with magnetic fields, the physical properties of high temperature gases, and other scientific areas. These experiments are extending hydrodynamic studies into much higher Mach regimes than possible with high pressure shock tubes.

To produce the high velocity shock wave, a large high-voltage charge is rapidly discharged from a bank of condensers at one end of the shock tube, creating a bubble of super-heated gas. Expansion of the hot gas "bubble" produces a high-velocity and intensely luminous shock wave which flashes down the tube. The wave is "boosted" to the tremendous speeds and temperatures by external magnetic fields which interact with the high-current discharge.

In continuing the development of supersonic missiles, a Lockheed *X-7* ramjet missile recently set three new speed records while completing its 10th successful flight—also a record for any single United States supersonic missile.

The record-busting "bird," which has been dubbed Methuselah by division technicians, thundered over the desert sands of the U.S. Air Force Missile Development Center near Alamogordo, N. Mex., on flight number 10.

The *X-7* celebrated this unprecedented longevity milestone by chalking up these three faster-than-sound records: (1) fastest speed for any ramjet powered missile, (2) fastest speed for any ground controlled missile, and (3) fastest speed for any recoverable missile. Its supersonic speed run was so fast, it was stated, that its paint was burned black by the blazing air-friction heat.

Because the *X-7* is recovered by parachute to be flown time and time again, each reflight saves taxpayers $350,000 in missile research costs, the Air Force stated. Thus, the Methuselah missile with its 10-flight record has already "banked" $3.5 million in missile expenditures.

This elderly *X-7* has successfully hit the silk an average of almost once a month since its first air launch. Engineers said it has never had to be returned to the missile division's Van Nuys plant for repairs. A rugged, workhorse for the nation's missile development program, the *X-7* wrings out powerful, new ramjet engines—or flying stovepipes—and other components for supersonic defense weapons.

Although officially designated *TV-20* (test vehicle 20), this *X-7* won its Methuselah nickname because of its long life, toughness, and reliability—outstanding even for the sturdy and dependable *X-7* missile family. In a field where the life of a missile is fast and furious—but brief—the long-lived *TV-20's* has been triple that of other birds of its type.

The average *X-7* has a life expectancy of three to four flights before it crashes or suffers damage requiring its return to the Lockheed missile plant for repairs. A flying laboratory operating miles high in the sky, the *X-7* radios performance data back to ground technicians as it maneuvers to test ramjet engines fully. Out of sight during most of its flight, it is piloted by earthbound engineers via radio.

It is launched from a *B-29* mother ship at a high altitude. A flame-tailed rocket booster zooms it to speeds where the ramjet takes over and the bird begins its supersonic excursion in the stratosphere.

The record shattering *X-7* will be returned soon to its birthplace at Lockheed's Van Nuys missile plant for the first time since its maiden flight in order for technicians to modify and clean it up a bit. Even for this Methuselah missile, now sporting symbols of 10 successful flights on its vertical fin, the fast fiery life is far from over as long as there are more new records to be set.

MAKING measurements of transistor characteristics are R. P. Abraham (*standing*) and R. J. Kirkpatrick at Bell Telephone Laboratories. Immediately in front of Mr. Kirkpatrick is the Diagraph, on the left is the signal generator, and to the right is the coaxial-jig setup required for the measurements.

Marked Advance Over Previous Types of Transistors

A type of transistor that "approaches the ideal electronic switch" for high-speed switching functions in electronic computers and automatic control systems has been developed experimentally by scientists of the Radio Corporation of America (RCA), it was recently announced.

The new device, called the "Thyristor," was described as "a marked advance" over both gas tubes and existing transistor switching devices because of its combination of simplicity, speed and "extremely low" power requirements.

"The Thyristor has a number of characteristics which come close to the ideal for "high-speed switching functions," said Dr. Irving Wolff, vice-president, research. "Among these are its ability to switch substantial currents from one circuit to another in periods as short as one fifty millionth of a second, and its ability to switch from OFF to ON and vice versa simply by the application of low energy pulses to the base circuit in one polarity or the other. This bi-stable performance characteristic will now permit us to do with one transistor a job that has previously required two."

The Thyristor may be operated either as a bistable switching element or as a more conventional high-frequency transistor, either in switching or in amplifying circuits, it was stated.

Although the new device has many of the propertes of existing types of gas switching tubes, it is "markedly superior" in many respects as a high-speed switching device. It was stated, for example, that the commercial gas switching tube cannot be switched OFF from the control element in the same way that it is switched ON, whereas the Thyristor is switched either way simply by changing the polarity of low energy pulses applied at the base.

Among the other principal advantages of the new device, according to the two scientists, are: (1) In operation it has an extremely low sustaining voltage, "of the order of a half volt at 100 milliamperes," permitting good ON-OFF stability. (2) It conducts very little current in the OFF position, "amounting to about 2 microamperes," which provides for a high-impedance OFF position. (3) It permits the use of simple circuitry for switching. (4) Fabrication of the Thyristor is "simple and can be carried out with ordinary diffusion and alloy techniques." A novel feature is a new form of collector contact which makes possible the high-speed switching action.

The device is still under development and is not yet commercially available.

In another development, a technique for accurately determining transistor characteristics in the grounded emitter configuration at 30 to 300 mc has been developed by R. P. Abraham and R. J. Kirkpatrick of Bell Telephone Laboratories, New York, N.Y. Details of this technique were covered in a paper presented at the National Electronics Conference in Chicago, Ill., on October 8, 1958.

Precise measurements of transistor characteristics in the vhf range have been made necessary by the increasing use and potential applications of transistors at frequencies up to 300 mc and even higher.

Four measurements and subsequent calculations are made which yield the four complex hybrid parameters, and from these the validity as well as the element values of any equivalent circuit may be determined. The four measurements are h_{11}, the short circuit input impedance; h_{22} the open circuit output admittance; y_{22}, the short circuit output admittance; and the insertion voltage gain. The calculations needed to transform the measured data to the hybrid parameters are programmed on a digital computer.

Measurements are made with the aid of a suitable r-f signal source and a Rhode-Schwarz Diagraph, used in conjunction with specially designed coaxial jigs. The Diagraph is an instrument capable of measuring the complex reflection coefficient, or immittance, and the transmission characteristics of the device under test. It contains a chart on which is indicated a vector whose length and angle are proportional to the magnitude and phase angle of the desired complex wave relationships.

To determine the h_{11} parameter, the input impedance of the transistor with the output terminated in 50 ohms is measured with the Diagraph. The coaxial jig used in this measurement is called the h_{11}—h_{21} jig. Inasmuch as the h_{11} parameter is defined as the short circuit input impedance, a small termination error exists and is allowed for in the calculations.

The h_{22} parameter is measured in much the same manner, except that the chart on the Diagraph is reversed so that admittance can be read directly. An h_{22}—y_{22} jig is employed in this measurement The h_{22} parameter is defined as the open circuit output admittance, so the base connection of the jig is a-c open-circuited.

The short circuit output admittance measurement, y_{22}, requires an a-c short between base and ground, which is provided in the h_{22}—y_{22} jig. Admittance is then measured directly in the same manner as described for h_{22}.

Insertion voltage gain is measured by utilizing the diagraph and the h_{11}—h_{21} jig. From the voltage gain and the known value of h_{11}, the short circuit current gain, h_{21}, can be calculated.

Reduction of the measured data to the desired parameters involves calculations which take into consideration three factors: the effects of shunt and series parasitics, imperfect terminations, and the effects of common impedances. The digital computer which makes the necessary computations is programmed to take these factors into consideration.

Achievements of Various Individuals

Defense Honors to RCA. Major General R. J. Browne, USAF, presented the Defense Department Reserve Award, including an official citation and a display pennant, to T. A. Smith, executive vice-president, RCA Industrial Electronic Products, at a ceremony in Camden, N. J.

The citation paid tribute to various RCA personnel policies which encourage and facilitate participation in Reserve activities, including provisions for leave of absence with differential pay for two weeks' training duty and arrangements for emergency nonmilitary duty.

In a letter of notification to RCA, C. E. Wilson, Secretary of Defense, said:

"The Department of Defense Award is provided to express the Department's appreciation for the outstanding co-operation to Reservists and Reserve activities achieved through the personnel policies you have established. You have thus encouraged and assisted your Reservists in fulfilling their military obligations. Such patriotic foresight provides a real assistance to the success of our Defense effort, and the Department is deeply grateful. May I add my personal thanks for this unselfish and patriotic assistance you are rendering the cause of national defense."

Standards Engineers Society Honorary Life Fellowship. Howard Coonley received the highest distinction, Honorary Life Fellowship, at the Sixth Annual Meeting Awards Luncheon of the Standard Engineers Society. Cyril Ainsworth, assistant secretary and technical director, American Standards Association; W. L. Healy, specialist, switchgear and control division, General Electric Company, Philadelphia; and George Noble, Dominion Engineering Company, Ltd., Montreal, Que., Canada, were selected by the Society to receive the Fellowship awards.

The Standards Engineers Society is an international professional society. It has 10 local sections in the United States and two in Canada.

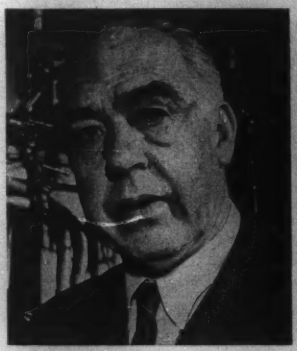
ASME Prime Movers Committee Award. For their paper, "Predicting Performances of Large Steam Turbine-Generator Units for Central Stations," two General Electric Company (GE) engineers have won the Prime Movers Committee award of The American Society of Mechanical Engineers. The winners are R. L. Bartlett and Heinrich Hegetschweiler, both employed by GE in Schenectady, N.Y. The award is made for outstanding published contributions to the literature of thermal electric station practice or equipment.

Atoms-for-Peace Award. Presentation of the first $75,000 Atoms-for-Peace Award was made to Professor Niels Bohr, 71-year old Danish scientist and dean of nuclear physics, during a special convocation at the National Academy of Sciences in Washington on October 24th. President Eisenhower headed the distinguished body of Government and United Nation officials, scientists, diplomats, and industrial leaders who attended the convocation.

The award presented to Professor Bohr was the first of 10 to be granted to those persons anywhere in the world who have made greatest contributions to the peaceful uses of atomic energy. It is made without regard for nationality, politics, or any other consideration except the merit of the contribution. The Danish physicist was selected from among 75 candidates proposed by scientific bodies in 23 countries.

The Atoms-for-Peace Awards were created in 1955 as a memorial to Henry Ford and Edsel Ford. Funds are provided by the Ford Motor Company Fund which has authorized $1 million for the purpose.

The award to Professor Bohr was presented by Dr. J. R. Killian, Jr., president of the Massachusetts Institute of Tech-



NIELS BOHR, Danish physicist and winner of the first Atoms-for-Peace Award, which was presented to Prof. Bohr by Pres. Eisenhower in Washington, D.C., on October 24th. In 1913, at the age of 28, the 72-year-old Dane captured the attention of world scientists with a concept which led to a new era in atomic research.

THE ATOMS-FOR-PEACE Award gold medal given to Danish physicist Niels Bohr. Established two years ago as a memorial to Henry and Edsel Ford, it is to be granted annually.

nology and chairman of the Board of Trustees of Atoms-for-Peace Awards. In addition to the $75,000 prize, Professor Bohr was presented with a sculptured gold medal executed by Sidney Waugh, well-known American artist.

The Franklin Institute Award. The John Price Wetherill Medal of the Franklin Institute of the State of Pennsylvania was awarded to W. W. Carpenter ". . . for his important contributions in the field of switching, including the invention of the Automatic Message Accounting System and many related inventions fundamental to the technology of modern telephone switching." Formal presentation was made at the Institute's annual Medal Day ceremonies held on October 16, as were other awards.

Recipient of the Elliott Cresson Medal of The Franklin Institute, was R. J. S. Pigott, consulting engineer of Pittsburgh, Pa. The citation read, ". . . in consideration of his engineering accomplishments, including his many valuable inventions, his painstaking research, his notable contributions to the technical press, and his engineering leadership."

Sir Robert A. Watson-Watt, radiophysicist of Toronto, Ont., Canada, also recipient of the Elliott Cresson Medal of The Franklin Institute and, incidentally, a distant kinsman of James Watt, father of the steam engine, is being cited ". . . for his conception of pulsed radar for the vital air defense of Great Britain, for his solutions of important technical problems, and for his inspiring leadership which resulted in the timely development of these radar systems."

Oak Ridge Appointment. Mr. Dorris N. Smith, from the University of Tennessee, has recently been appointed to the staff of the Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn., an Atomic Energy Commission installation operated by Union Carbide Nuclear Company, a division of Union Carbide Corporation.

The National Safety Council Appointment. Two staff executives for programs have been appointed by the National Safety Council. One has been a member of the headquarters staff four years. H. J. Hoeffer, 55, Denver, Colo., and Ralph Kuhli, 45, Wheaton, Ill., were named to the positions. Mr. Kuhli formerly was assistant director of the Council's Home Safety Division.

The new staff executives, said Gen. G. C. Stewart, executive vice-president of the Council, will work with the assistant general manager for programs in developing programs and services of various departments, and in evaluating effectiveness of the programs.

NSF Staff Members Appointed. Three new appointments to the staff of the National Science Foundation (NSF) were announced by A. T. Waterman, director of the Foundation. Geoffrey Keller has been named program director for astronomy. Division of Mathematical, Physical, and Engineering sciences; W. J. Peterson, program director for special projects in science education, Division of Scientific Personnel and Education; and N. T. Spratt, Jr., program director for developmental biology, Division of Biological and Medical Sciences.

Dr. Keller is on leave of absence from Ohio State University where he has been professor of physics and astronomy since 1948, and director of the Perkins Observatory since 1953. Dr. Peterson's duties will include supervision of the Foundation's experimental programs in science education. Dr. Spratt is on a year's leave of absence from the University of Minnesota.

Chief Scientist, U. S. Air Force. Dr. G. E. Valley of the Massachusetts Institute of Technology has assumed duties as chief scientist of the U. S. Air Force. Dr. Valley succeeds Dr. C. D. Perkins who has returned to Princeton University as chairman of the Aeronautical Engineering Department.

ASCE Elections. The American Society of Civil Engineers elected L. R. Howson, of Chicago, Ill., president for one year. Mr. Howson, was installed October 16, 1957, at the annual meeting of ASCE in New York, N.Y. Two vice-presidents and six directors, all newly elected, took office at the same time.

The vice-presidents, who will serve two years each, are: W. G. Bowman, New York, editor of *Engineering News-Record;* and S. B. Morris, Los Angeles, former general manager of the City of Los Angeles department of water and power and a consulting engineer.

The new directors, elected for three years each, were Prof. W. S. Evans, Orono, Me., head of the department of civil engineering, University of Maine; C. P. Hazelet, Louisville, Ky., partner in Hazelet and Erdal; D. H. Mattern, Knoxville, Tenn., chief, project planning branch, TVA; J. E. Rinne, San Francisco, Calif., engineer, Standard Oil Co. of California; P. C. Rutledge, New York, N.Y., partner in Moran, Proctor, Mueser and Rutledge; T. E. Shelburne, Charlottesville, Va., director, Virginia Council of Highway Investigation and Research.

Promoted to Brigadier General. The promotion of R. J. Meyer to the rank of Brigadier General was announced by the Department of the Army recently. General Meyer is Chief of the Research and Development Division, Office of the Chief Signal Officer, Washington, D.C. He has had numerous assignments related to research and development. In particular, he organized the Communications–Electronics Test Section of Army Field Forces Board #1 (now Board #5). He recently completed an assignment with NATO as Signal Officer of Headquarters Allied Land Forces Southwestern Europe in Izmir, Turkey.

30 Million Words and 18 Years Ago. Avron Pernick joined the General Electric Company as a translator some 30 million foreign words and 18 years ago to become an important part in following the technical engineering progress being carried out in foreign countries.

Mr. Pernick recently retired from the Schenectady Plant's Main Library.

Scores of foreign technical reports, trade journals, and patent applications were translated by him in the past two decades. Although Mr. Pernick preferred to translate French, he was also qualified to translate German, Russian, and Swedish.

New Electron Tube for Use in Defense Radars

Development of a new electron tube designed to increase the power in the nation's vital radar defense networks, was announced recently by the Department of the Army.

Known as the "amplitron," the new tube combines the best features of existing radar boosters and, at the same time, doubles their efficiency.

Developed by the U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., and the Raytheon Manufacturing Company, Waltham, Mass., the tube now makes possible lighter, more compact, and versatile radar sets.

Although the amplitron works on the same principles as the ordinary television and radio tube, it has a different appearance. It is encased in a disc-shaped metal case with power connections projecting from its edges. It weighs 10 pounds and is extremely light for its capacity.

Because of its unique design, the amplitron is twice as efficient as previous tubes used in radar and is capable of boosting the energy output of a radar's basic signal by as much as 8 to 14 times.

In addition, the tube's ability to respond to a wide range of signals makes possible rapid tuning to evade enemy jamming or interference.

The amplitron can handle a power load equal to that needed to light a small community. Its advanced features will allow lighter radars for airliners, long-range storm spotters for weathermen, electronic ovens, better guided missile systems, more dependable and lighter gun-radars for jets, and sharper warning devices for submarines and surface ships.

The new tube can perform secondary functions of generating basic radar waves. The constant and unwavering signal is 10 times steadier than now is possible with the high power magnetrons, thereby improving radar's ability to spot a moving target farther away and with greater precision.

Communications Center Self-Contained Truck Trailers

A civil defense version of the famous French "taxicab army" that saved Paris from attack during World War I is being mapped out at Milwaukee, Wis., as part of the city's preparedness program against enemy bombing or other sudden disaster.

Nerve center for Milwaukee's Civil Defense Administration (CDA) in case of emergency will be two 35-foot truck trailers especially designed and built to serve as self-contained communication hubs, complete with telephone, teletype, radio-teletype, and two-way radio systems.

Believed to be the first of their kind

in the nation, the units were built by the Highway Trailer Company, Edgerton, Wis., to specifications developed by the Milwaukee CDA. One has been delivered to date, and the other is nearing completion.

Designed to be completely self-sufficient, the trailers will be power packed with both radio and telephone equipment capable of handling a heavy message volume should the city's permanent communications facilities all be destroyed. Known as "Mobile Communications Control Units" the trucks will be stationed outside the city, on opposite sides of Milwaukee, to safeguard them in case of disaster or attack. Constantly manned, they will be ready to roll at a moment's notice.

As part of its planning, the Milwaukee CDA has torn a page from lessons learned in the defense of Paris in 1918. In addition to directing fire, police, rescue, and first aid units, the trailers will be tuned in to the wavelength of Milwaukee's taxicab fleets. Each cab instantly will become both an emergency CDA vehicle and a mobile radio station capable of relaying orders and requests for aid and assistance.

Inside the trailers will be a mass of communications equipment that is seldom packed into such compact space. Radio and telephone apparatus specially engineered for the purpose will rub shoulders with teletype and radio-teletype and other shortwave equipment.

Each unit will carry its own electric generating equipment and can, if necessary, supply current to others for a short period of time. The trailers are also equipped to take electric power from outside sources in case of a generating failure within the vehicles.

Made of all steel construction, the trailer units have specially reinforced roofs capable of carrying one ton of collapsible radio antenna. Completely insulated, the vans will be heated in Winter and air-cooled in Summer.

Aerial Gas Stations Advertise Their Locations

In-flight refueling of U. S. Air Force planes anywhere in the world now is a routine operation largely because of an airborne "homing beacon."

The high powered radar beacon developed by the Air Research and Development Command (ARDC) makes it possible for fuel-hungry airplanes to rendezvous with flying tankers day or night, or in any kind of weather. Its long range enables squadrons of planes to pinpoint the exact location of scheduled tanker planes from hundreds of miles away.

Designated the *AN/APN-69*, the compact beacon was developed jointly by ARDC's Wright Air Development Center (WADC) and the Sperry Gyroscope Company.

In air-to-air operations, the beacon is installed in a designated rendezvous aircraft. Other aircraft wishing to "home" on the beacon from hundreds of miles away use interrogating radar to send out pulses of a specific type to trigger the beacon. In response to the proper interrogation signal, the beacon transmits a coded reply. The operator of the interrogating radar is thereby able to identify the beacon-equipped aircraft, as well as to determine its exact range and bearing.

Maj. Gen. T. L. Bryan, Jr., WADC commander, said suitability tests have been run from the arctic to the tropics, including many overseas flights, with refueling planes operating from bases along the way. The beacons have been improved since their original development and now are being produced in quantity for Air Force use.

Project engineer during the development of original models of the beacon was M. L. Dervage, of Dayton, Ohio, who now is chief of the command and homing section in the Weapons Guidance Laboratory. Present project engineer, who gives technical guidance in procurement of the beacons and their operational use, is R. L. Smith, of Dayton.

"Hot Spot" Assists Research

Thirty feet above ground, a 5/8-inch "hot spot" of concentrated sunlight is providing up to 6,000 F of solar heat to assist scientists in various research tasks at the Stanford Research Institute (SRI). It is the focal point of a new solar furnace which will enable the staff at SRI to conduct certain experiments not possible or convenient with other heat sources.

The facility is not really a furnace, but rather an optical system by which solar radiations are concentrated in a small area. The system consists, primarily, of two mirrors and a target. One mirror, called a heliostat, is flat and movable, and is mounted near the ground. It reflects the rays of the sun upward to a curved stationary mirror that "looks" downward, focusing the rays to create a "hot spot" on a target specimen or crucible about two feet below.

The heliostat actually is a group of nine back-silvered mirrors mounted on a cradle which is turned by a control system at a rate necessary to track the sun. The mirrors are tilted as a unit to deflect the sunlight toward the curved, polished aluminum mirror, or paraboloid which is set 32 feet above it. The mounting-plate target, at the end of a retractable framework, has a shield that can be swung over the target specimen to shut off the heat.

Maximum efficiency is provided by this design in concentrating the solar heat to be consistent with the greatest possible advantage in operation and use. Compared with the type of solar furnace in which the entire apparatus moves to follow the sun across the sky, the design permits the target specimen to remain stationary with the specimen or crucible horizontal and facing upward. Although it requires two mirrors, the second mirror causes a very small heat loss of 200 to 300 F.

The advantages of this solar furnace are numerous. Temperatures of 6,000 F can be obtained by other means, such as, actual flame, electrical resistance, arcs, or electrical induction. The solar furnace is advantageous over such methods because the radiant energy obtained is a kind of "pure" heat and does not produce contaminants as do other heat sources. Inasmuch as the heat is concentrated in a very small area, the specimen alone is heated. This heat concentration permits the quick attainment of high temperatures and subsequent rapid cooling.

Because the hot spot is very sharply defined, it is possible to obtain a sharp temperature gradient: that is, an inch away from the center of the spot, the temperature drops to over 3,000 F. Also, the movable shield and other types of shutter permit quick shut-off or partial reduction of applied heat, thus providing specific heat control.

Work on a variety of research tasks has begun where super-pure materials are needed or prepared. Measurement of thermal characteristics and conductivity of materials at high temperatures is easier with this type of furnace. Other studies will be taken as they occur.

Automatic System Lands Jet Aboard Carrier

For the first time in aviation history, a U. S. Navy fighter airplane has been landed aboard an aircraft carrier by a system combining radio and radar without the pilot touching the controls during the landing.

Recently, an *F3D* jet airplane has made repeated landings aboard the aircraft carrier *U.S.S. Antietam* operating in the Gulf of Mexico, a Navy announcement said. The landing system has been developed by Bell Aircraft Corporation, of Buffalo, N.Y., under contract with the Navy's Bureau of Ships.

Previous to its actual use aboard the carrier, the system had landed various types of military and commercial aircraft more than 1,800 times during development and testing at the Niagara Falls, N.Y., airport as well as at several military installations.

The new system is a combination of radar and radio. It takes over from the pilot while the airplane still is some distance from touchdown on an airport runway or a carrier deck and brings the plane in for a safe landing. A significant feature is that it has been developed for use even when normal flight operations are suspended because of dense fog or other unfavorable weather conditions. The pilot need not see the airport or locate the aircraft carrier before the automatic landing is completed.

During the *Antietam* trials, radar located the *F3D* and determined its altitude and location with relation to the carrier deck. An electronic computer did the rest, sending the necessary course corrections to an automatic pilot which directs the airplane into the desired flight path and final landing.

When the system "locks on" to the airplane, the pilot immediately relinquishes control and rides the airplane into touchdown virtually as a passenger.

If the carrier deck is not in the proper position for a safe landing, the system automatically gives the pilot a "wave-off" and the airplane is flown around the landing pattern for another attempt. During tests at the Niagara Falls airport, the system landed a Navy pilot repeatedly during blinding snow squalls.

In addition to over-all accuracy, the *Antietam* operations in the Gulf of Mexico were made to evaluate the system with relation to longitudinal and lateral dispersion of the landings.

The Navy requires that the automatic system land the airplane within a distance not exceeding a standard deviation of ±30 feet longitudinally and a maximum of ±25 feet laterally from a pre-established landing spot on the deck. During 120 landings made on an airport runway, the system landed an airplane with an average longitudinal dispersion of less than 18 feet. The lateral dispersion was negligible.

Bell Aircraft engineers point out that the system has significant commercial as well as military application and would permit operations at commercial airports when weather conditions prevent pilots from making visual landings.

The testing program aboard the *Antietam* was conducted by the Carrier Suitability Section of the Flight Test Division, Naval Air Test Center, Patuxent River, Md. There were about 30 engineers aboard who were representatives of various organizations.

Standards Accord Reached at Conference

A conference called by the national standards bodies of Canada, Great Britain, and the United States assembled in Toronto, Ont., Canada, October 7-11, 1957, to achieve a tripartite international accord on drafting practices. The announcement, made by Vice-Admiral G. F. Hussey, Jr., USN (Ret.), managing director of the American Standards Association (ASA), voluntary national standards body for United States commerce, industry, Government, and consumer interests, stated that 21 delegates from ASA were to attend the ABC Conference on the "Unification of Drafting Practice."

The leader of the ASA delegation was R. P. Hoelscher, professor, University of Illinois, Urbana. He has been chairman of the ASA committee responsible for standard drafting practices since its reorganization in 1948. It was stated that the American Drafting Standards Manual, four sections of which have been approved by the ASA, would provide the basis for the United States delegates in presenting this country's viewpoint.

The American Society of Mechanical Engineers (ASME) is planning to publish the Manual. When completed, the Manual will consist of 17 sections, each individually approved as American Standards by the ASA.

The sections approved to date are: Section 1, Size and Format; Section 2, Line Conventions, Sectioning, and Lettering; Section 3 is out on letter ballot for approval; Section 4, Pictorial Drawings; and Section 5, Dimensioning and Notes. Section 5 and comparable portions of the Canadian and British Standards comprised the only major area in which serious differences still existed at the start of the Conference. The prime purpose of the Toronto meeting was to chart a path for reconsidering these differences.

ASME and the American Society for Engineering Education (ASEE) provided the administrative leadership of the ASA Committee on Drawings and Drafting Practice, Y14. Technical representatives of 29 national organizations from industry, engineering societies, and educators as well as the military services have been engaged for nearly 10 years in a drive to develop standards of national acceptability.

The objective of the American delegation which was to carry the Y14 work one step further—to reach an accord insofar as possible with Great Britain and Canada—was achieved. Discussions revolved around areas of agreement and disagreement in the drafting practice of each country. Particular attention was directed to the specification of true positions and geometric tolerances and maximum material conditions on drawings. The use of symbols to express geometric forms also were discussed, recommendations were made, and the agreements reached were to be taken to the countries of the delegates for confirmation and approval.

This accord provides designers with a common form of technical communication which should lead to lower costs and improved security inasmuch as interchangeability in manufactured parts could be achieved.

Six active members of ASA Committee Y14 presented the following papers: "Areas of Agreement and Disagreement of the United States, Great Britain, and Canada," R. P. Trowbridge and Leon DeMause, General Motors Corporation; "Specifications of True Position Tolerance," N. E. Brown, Taft-Pierce Company, and Joseph Stannard, Pratt & Whitney Company; "The Need for Standard Symbols for Geometric Forms," S. C. Miller, Department of the Navy; and "American Approach to the Specification of Maximum Material Conditions on Drawings," P. G. Belitsos, General Electric Company.

The last major ABC accord in the field of engineering standards was reached in 1948 and resulted in a unified screw thread system based on the inch. The British, at the time, abandoned their historic Whitworth (55 degree) thread in favor of the American (60 degree) thread.

In May 1957, at a meeting of a technical committee held in Lisbon, Portugal, the "Unified Screw Thread System" developed by the ABC countries was recommended for adoption by the International Organization for Standardization (ISO). If approved in ISO, this will achieve equal status for both the inch screw thread and metric screw thread systems.

The ASA representative on the ABC Steering Committee is Vice-Admiral Hussey. Members of its technical delegation are: Prof. Hoelscher; Mr. Belitsos; Mr. Brown; A. P. Corridon, U.S. Army Ordnance Corps, Department of the Army; Mr. DeMause; J. J. Dunn, Office of Assistant Secretary of Defense (Supply and Logistics); F. D. Floto, Wright Air Development Center; C. H. Heller and E. H. Jones, Bell Telephone Laboratories, Inc.; C. L. Miller, Office of Assistant Secretary of Defense (Supply and Logistics); S. C. Miller, U.S. Navy Bureau of Ordnance, Department of the Navy; C. C. Muller, Office of Assistant Secretary of Defense (Supply and Logistics); Benjamin Orr, U.S. Army Signal Corps, Department of the Army; Prof. R. S Paffenbarger, Ohio State University; Prof. C. H. Springer, University of Illinois; Harry Springer, U.S. Army Corps of Engineers; Mr. Stannard; Craig Telfer, Eastman Kodak Company; Mr. Trowbridge; and S. H. Watson, Radio Corporation of America.

Accredited observers are: Prof. Jasper Gerardi, University of Detroit; C. McMahon, Bay State Abrasive Products Company; C. A. Slater, Bendix Aviation Corporation; and F. H. Smith, University of Michigan.

Staff members of the two organizations who attended the Toronto meeting were: J. W. McNair and C. E. Hilton, ASA; Frank Philippbar and J. D. Wilding, ASME.

ARDC Facts, Mission and Organization

The U. S. Air Force consolidated its many research and development activities in 1950 in order to achieve and maintain qualitative superiority, by establishing the Air Research and Development Command (ARDC). In a statement of the mission for ARDC, three essential responsibilities were set forth. First, attain and maintain qualitative superiority of materiel and conduct or supervise scientific and technical studies required; second, seek new basic knowledge from which improved aeronautical equipment, materiel, weapons, and techniques can be developed; and third, undertake the development and recommend the adoption of new and improved devices and systems for the conduct and support of air warfare, including complete weapon systems, techniques, and procedures applicable to Air Force (AF) purposes.

From headquarters in Baltimore, Md., ARDC directs operation of its 10 major research, development, and test centers throughout the country and co-ordinates the nation's scientific talent. Because all requirements of research and development cannot be performed by ARDC personnel alone, as of March 1957, a large percentage of this effort was delegated among 250 universities, colleges, and other nonprofit institutions and 1,750 industrial concerns. There are 22 domestic field offices to provide technical laision with industry and other military services. An interchange of technical information is maintained with the U. S. Army and Navy, and other Government organizations.

Wright Air Development Center at Wright-Patterson AF Base, Ohio, is one of the world's most extensive and completely equipped facility devoted to aeronautical development. Some 13 techuical fields are in the comprehensive program carried forth.

Rome Air Development Center, Griffiss AF Base, Rome, N. Y., develops, tests, and provides technical support for the AF inventory of ground electronic systems and equipment.

AF Missile Development Center, Holloman AF Base, N. Mex., conducts a program of research and development in guided missiles, electronics, geophysics, physiology, biophysics, and psychology.

Arnold Engineering Development Center, Tullahoma, Tenn., constructs and operates a series of wind tunnels and high-altitude test cells for the developmental testing and evaluation of aircraft, guided missiles, and air-breathing propulsion systems.

AF Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass., carries out a program in electronics, geophysical sciences, and human engineering, as well as some special areas of radio biology and radio chemistry.

AF Flight Test Center, Edwards AF Base, Calif., flight tests aircraft, power plants, components, and allied equipment. The Center also maintains the Experimental Rocket Engine Test Laboratory, the USAF Experimental Flight Test Pilot School, and the USAF Parachute Test Group at El Centro.

AF Missile Test Center, Patrick AF Base, Fla., tests long-range guided and ballistic missiles and target drones from Cape Canaveral, Fla., to Ascension Island.

AF Armament Center, Elgin AF Base, Fla., performs engineering evaluation tests on aircraft bombing and firing systems and their components.

AF Special Weapons Center, Kirtland AF Base, N. Mex., tests and develops nuclear and thermonuclear weapons, components, and associated equipment. Provides support to Atomic Energy Commission (AEC) and other Government agencies in conducting continental and overseas weapons tests.

AF Personnel and Training Research Center, Lackland AF Base, Texas, makes predictions of the personnel demands which will result from projected weapons systems, and have extension laboratories located throughout the United States.

Three other organizations which are integral parts and report directly to ARDC are: Armed Services Technical Information Agency (ASTIA), Dayton, Ohio; AF Office of Scientific Research (AFOSR), Washington, D. C.; and the Office of Aircraft Nuclear Propulsion, Washington, D. C.

Under sponsorship of ARDC's AFOSR, Litton Industries, Inc., recently designed and constructed an altitude chamber which enabled a Litton scientist, Niels Jensen of Beverly Hills, Calif., to go as high as 95 miles up without leaving the ground. The high-altitude chamber is 15 feet long and 8 feet wide. A special pressure suit developed for the USAF ARDC was used to protect him against the simulated conditions that exist in the thin atmosphere 95-miles above the earth. Another important area to be explored in this new laboratory is electron-tube research.

Calibration and adjustment of AF electronic test equipment for maximum accuracy will be improved greatly by a new certifying standard believed to be the first of its kind. Developed for ARDC by design engineers at WADC in co-operation with Weinschel Engineering Co., the new standard is composed of a direct read-out precision power meter and a voltage ratio calibrator. Plans are to install certifying standards at AF depots so that electronic equipment manufacturers can bring their test equipment to the depot at regular intervals.

Radomes, normally made of reinforced plastic, have a tendency to char and lose strength when subjected to extreme heat. Because of this, ARDC is looking to other materials for use in missiles which re-enter the atmosphere at high speeds and increased temperatures. Recently, the first 10 prototype "high-alumina" ceramic radomes were completed by Gladding, McBean & Co. for the ARDC. The technique used begins with high-purity alumina ($Al_2 O_3$). This is mixed with an organic binder before it is fired in a furnace. It is oven dried, covered with neoprene and subjected to 30,000 psi, stripped from its core and given a preliminary firing at 2,200 to 2,250 F, machined to final wall thickness, and given a final firing at over 3,000 F in a regenerative type kiln.

Progress of the Atomic Energy Commission

Reactor Advisory Group. The U. S. Atomic Energy Commission (AEC), through Chairman L. L. Strauss, announced appointment of a new Advisory Committee on Reactor Safeguards established as a statutory committee by a recent amendment to the Atomic Energy Act of 1954 enacted by the 85th Congress of the United States.

Nine members have been appointed thus far. Additional members, within the maximum of 15 provided in the amended Act, will be appointed later.

The statutory Advisory Committee on Reactor Safeguards is to review and report on safety studies and facility license applications referred to it, advise the AEC on the hazards of proposed or existing reactor facilities and the adequacy of proposed reactor safety standards, and perform such other duties as the AEC requests. Included among applications which are to be referred to the group for safety evaluation are those for power and testing reactors. The Act provides that the Committee's reports on these shall be made available to the public.

Those appointed to the newly formed advisory group are: Dr. Manson Benedict, professor of chemical engineering, Massachusetts Institute of Technology; Dr. Harvey Brooks, dean of engineering and applied physics, Harvard University; Dr. R. L. Doan, manager, Atomic Energy Division, Phillips Petroleum Company, Idaho Falls, Idaho; Dr. Mark Mills, associate director, Radiation Laboratory, University of California, Livermore, Calif.; K. R. Osborn, manager of industrial development, General Chemical Division, Allied Chemical and Dye Corp., New York, N. Y.; D. A. Rogers, manager, central engineering, Allied Chemical and Dye Corp., Morristown, N. J.; R. C. Stratton, assistant director, department of research, engineering and loss control, the Travelers Insurance Companies, Hartford, Conn., and Dr. Abel Wolman, head, department of sanitary engineering and water resources, the Johns Hopkins University, Baltimore, Md.

In addition, Dr. C. R. McCullough, former deputy director for hazards evaluation in the AEC's Division of Civilian Application, has been appointed to the Committee.

Export License for Research Reactor Shipment. The AEC has filed notice of proposed issuance of a license to Mitsubishi International Corporation of New York, N. Y., for export of a research reactor to Japan.

The company plans to ship a 10,000-kw (thermal) reactor to the Japan Atomic Energy Research Institute in Tokyo. The reactor is a tank type, heterogeneous, heavy-water cooled and moderated facility.

Proposed issuance of the export license is based on a determination that it is within the scope of and consistent with the agreement for co-operation between the Governments of the United States and Japan. Notice of the proposed issuance was filed with the Federal Register on September 25, 1957.

Permit for Construction of Argonaut Type Reactor. Notice was filed by the AEC that it proposes to issue a permit to Daystrom, Incorporated, for construction of an "Argonaut" type research reactor in West Caldwell, N. J.

The proposed Daystrom Argonaut Reactor to be known as DART is an exact copy of the Argonaut reactor developed by the Argonne National Laboratory near Lemont, Ill.

Notice of proposed issuance of the construction permit was filed with the Federal Register on September 25, 1957.

Patents Released for Public Use. Descriptions of 50 patents owned by the U. S. Government and held by the AEC have been released by the AEC.

Nonexclusive, royalty-free licenses will be granted by the AEC on the listed patents, as part of its program to make nonsecret technological information available for use by industry. AEC-held patents and patent applications released for licensing now total 1,269.

The list of patents giving number, title, inventor, and abstract is available from AEC, Washington 25, D. C. Applicants for licenses should apply to the Chief, Patent Branch, Office of the General Counsel, U. S. Atomic Energy Commission, Washington 25, D. C., identifying the subject matter by patent number and title. Copies of these patents may be obtained from the U. S. Patent Office.

Department of Defense and AEC Statement. In the absence of a safeguarded disarmament agreement, preparations are under way by the AEC and the Department of Defense for a series of nuclear tests to begin in April 1958, at the Eniwetok Proving Ground in the Pacific. The United States repeatedly has stated its willingness to suspend nuclear tests as part of a disarmament agreement. Until such an agreement is attained, continued

development of nuclear weapons is essential to the defense of the United States and of the Free World.

The forthcoming series will advance the development of weapons for defense against aggression whether air-borne, missile-borne, or otherwise mounted. Information on the effects of weapons will be obtained for military and civilian defense use. Test operations will be governed by the declaration made in the Bermuda Communique on March 24, 1957, of the intention of the United States ". . . to conduct nuclear tests only in such manner as will keep world radiation from rising to more than a small fraction of the levels that might be hazardous."

An important objective of the tests will be the further development of nuclear weapons with greatly reduced radioactive fallout in order that radiation hazard may be restricted to the military target. This principle was first proved in the Pacific test series of 1956.

A United Nations agency will be invited to designate an international group to observe one of the detonations involving limited fallout and studies are under way to determine the instrumentation which will facilitate their observation without making disclosures which would compromise restricted weapon information in violation of the Atomic Energy Act of 1954. Observation by news media representatives will be provided for in a manner to be announced later.

As in the past series, a control area surrounding the proving grounds will be established to safeguard air and sea traffic and will be defined well in advance of the commencement of these test operations.

Fissionable Material Transport Safeguards. The AEC has invited comment on a proposed regulation to guard against accidental conditions of criticality in the shipment of special nuclear material. Although there could be no bomb-like explosion in such a case, there might, in cases of sufficiently large shipments, be spread of radioactive material in the vicinity.

Requirements to protect against accidental conditions of criticality have been incorporated in the past in specific licensing actions.

Limits would be placed in the proposed regulation on the amounts of plutonium, uranium-233, and uranium enriched in the isotope uranium-235 which a licensee might transport or deliver to a carrier for a single shipment. Shipments in excess of these limits would be permissible only after approval by the AEC.

The limits would be:

Material	Transportation by a Licensee (any one of the following)	Delivery to a Carrier (any one of the following)
Uranium enriched in the isotope Uranium-235	350 grams contained Uranium-235	100 grams contained Uranium-235
Uranium 233	200 grams	60 grams
Plutonium	200 grams	60 grams

Formulas would be provided in the regulation for determining the permissible amounts in mixed shipments.

The proposed regulation would provide that a licensee might deliver as much material to a carrier as he might transport himself under controls to assure that the total quantity shipped was within permissible limits.

The proposed regulation—10 Code of Federal Regulations Part 71, "Regulations To Protect Against Accidental Conditions of Criticality in the Shipment of Special Nuclear Material"—was published in the Federal Register on September 21, 1957.

Unclassified Physical Research Contracts. Awards of 57 unclassified physical research contracts with universities and private research institutions was announced recently by the AEC. New contracts amount to 16, and the remainder are renewals of contracts which have been in force.

The contracts are for a term of one year, as part of the AEC's continuing policy of utilizing private research laboratories in conducting research related to atomic energy. The contracts awarded are as follows: (*New contracts*) University of Arkansas, mass spectrometry instrumentation, $25,600; University of Arizona, coulometric analysis of rare-earth elements at controlled potentials, $7,000; Carnegie Institute of Technology, effects of hydrogen and nitrogen in niobium, $7,393; Case Institute of Technology, purchase of an HVEC type *KN (V)* Van de Graaff accelerator for installation at CIT, $185,000; University of Colorado, design of a 10- to 30-mev cyclotron and associated structures, $76,800; Illinois Institute of Technology, color center and related phenomena in sodium cyanide single crystals, $6,000; University of Illinois, fatigue behavior of dilute alloys of niobium, $22,912; Kentucky Research Foundation, solvent extraction and spectrographic analysis of rare earths, $19,500; University of Maryland, structure of light nuclei and purchase of a 3-mev Van de Graaff accelerator, $250,180; University of Michigan, electric and magnetic resonance absorption, $58,280; University of Michigan, investigation of thermodynamic activities in bismuth systems, $9,165; Ohio University, the pinacol rearrangement of 1, 1, 2-trimethylethylene glycol, $7,500; University of Pennsylvania, high-energy research programs, $73,000; University of Southern California, nuclear physics with a 32-mev proton linear accelerator, $107,090; Yale University, the structure of metallic liquids, $12,425; and Yale University, research with a heavy-ion accelerator, $160,000. (*Renewals*) University of Arkansas, nuclear chemistry research, $53,391; Brown University, reaction studies with fast neutrons, $24,930; University of Buffalo, applications of isotopes in chemical kinetics, $21,000; California Institute of Technology, research in high-energy physics, $399,000; University of California, Berkeley, intermolecular forces and solubility, $11,176; University of California, Davis, precision beta-ray spectrometer, $18,056; University of California, Berkeley, thermodynamic functions for the metallic state, $15,000; Carnegie Institute of Technology, X-ray studies of lattice imperfections, $23,722; Carnegie Institute of Technology, the standard free energy of formation of certain rare-earth carbides, $25,784; Carnegie Institute of Technology, fundamental study of the early stages of sintering, $24,730; University of Chicago, synchrocyclotron operation, $45,860; Duke University, fast neutron cross sections and shell structure, $84,000; Florida State University, exchange between labelled halogens and certain inorganic halides, $7,611; Florida State University, radiation-induced effects in heterogeneous organic systems, $10,207; Horizons, Inc., electrolytic extraction of niobium, $33,630; University of Illinois, isotope exchange reactions in nonaqueous solvents, $7,688; University of Illinois, research on radiation damage, $148,515; Indiana University Foundation, study of inorganic salts at high temperatures, 13,-168; Kentucky Research Foundation, study of nuclear energy levels, $33,268; University of Louisville, synthesis and properties of ion-exchange resins, $6,424; University of Louisville, organic radiation chemistry, $28,175; Massachusetts Institute of Technology, effects of plastic strain on the diffusion process, $31,950; University of Michigan, 42-inch cyclotron program, $6,793; University of Michigan, study of high-energy nuclear interactions, $104,500; University of Minnesota, 68-mev proton Linac, $322,523; University of Nebraska, energy transfer of slow ions, $18,000; University of Notre Dame, radiation chemistry studies, $279,700; University of Notre Dame, interaction of photons and particles with nuclei, no fund; Ohio State University, nuclear spectroscopy, $18,410; University of Oklahoma, spectroscopic properties of fluorocarbons and fluorinated hydrocarbons, $10,908; Purdue Research Foundation, polarography in nonaqueous solvents, $4,500; Reed College, diffusion of cathodic hydrogen through metals, $8,677; Rensselaer Polytechnic Institute, a study of complex ions in fused melts, $10,000; Rice Institute, nuclear physics research, $83,160; University of Rochester, studies of spallation reactions, $20,460; Southern Research Institute, surface tension of fused salts, $47,500; Stanford Research Institute, fundamental study of fused salts and fused salt-metal systems, $75,000; Stanford University, electron Linac component development, $174,000; University of Tennessee, determination and application of separation factors for some chemical fractionalizations of hydrogen isotopes, $4,070; University of Texas, neutron experiments with a Van de Graaff generator, $45,804; and University of Virginia, problems of high-speed rotation, $160,914.

Licensing Actions. The AEC has issued the following construction permits and licenses:

An export license, dated September 18, 1957, issued to AMF Atomics of New York, N. Y., for shipment of a 1,000-kw (thermal) pool-type research reactor to the Portuguese Atomic Energy Commission, Lisbon.

The University of Virginia has received a permit, dated September 13, 1957, for construction of a pool-type research reactor, operating at a maximum power

level of 1,000 kw of thermal energy, near Charlottesville.

Licenses dated September 12, 1957, were issued to Colorado State University, Fort Collins, Colo., and the University of Utah, Salt Lake City, Utah, to acquire and operate 100-milliwatt research reactors for use in training students in nuclear technology and in research and development work.

The University of Michigan has received a license, dated September 13, 1957, for operation of a 1,000-kw (thermal) pool-type research reactor in the Phoenix Memorial Laboratory building on the University's North Campus at Ann Arbor.

The United States Naval Hospital at Bethesda, Md., has received a license dated September 13, 1957, for operation of a 5-watt research reactor for use in medical research radioisotope production, and training of personnel.

Assignment of Production Reactor Design. The AEC has assigned to the General Electric Company (GE), operator of the AEC's Hanford Works, the engineering design of a large-scale reactor for the production of special nuclear materials. Development, design, and engineering work on such a plant has been authorized by the Congress of the United States.

The AEC assigned the work to GE because a significant amount of the information needed for the engineering design has been developed by the company in the continuing research and development program conducted to improve the performance and safety of Hanford production reactors.

A report on the design, including cost estimates and schedule of construction, is to be submitted by the AEC to the Joint Committee on Atomic Energy of the Congress not later than April 1, 1958. Construction of the production reactor has not been authorized by the Congress. No site for the nuclear reactor plant has been selected.

Research Reactor in Orange County. The AEC has filed notice that it proposes to issue a permit to Union Carbide Corporation of New York, N. Y., for construction of a research reactor at the company's new research center in Orange County, N. Y.

Union Carbide has contracted with AMF Atomics, Inc., to design and build a 5,000-kw (thermal) research reactor of the pool type for use in studies of the effects of radiation on products and processes involving plastics, gases, metals, carbons, and chemicals.

The proposed reactor will be a modified version of the Bulk Shield Test Facility developed at the AEC's Oak Ridge (Tenn.) National Laboratory.

Notice of the proposed issuance was filed with the Federal Register on October 2, 1957.

Research Reactor Components Test Facility. The AEC has issued a permit to GE for construction of a nuclear check-out test of the core and components of the pool-type research reactor the company has been licensed to export to the Junta de Energia Nuclear, the Spanish Atomic Energy Commission, at Moncloa, near Madrid, Spain. The permit is dated September 20, 1957.

Notice of proposed issuance of the permit was published in the Federal Register on September 6, 1957.

Telephone Developments

Pushbutton Radiotelephone. A push-button-dialing radiotelephone system which was developed by Motorola, Inc., according to Arthur Reese, vice-president, Communications and Industrial Electronics Division, for the Rural Electrification Administration (REA), enables telephone companies with automatic telephone exchanges to provide radiotelephone service to both home and mobile radio users in sparsely populated areas. Previously, it was necessary to have an operator on duty in order to provide radiotelephone service.

The new system has been field-tested for several months and engineers have termed the results excellent.

This type of system is expected to be especially attractive to mobile radiotelephone users such as taxi companies, trucking firms, repair and service businesses, and—along coastal areas—fishing and pleasure cruise boats and off-shore drilling rigs.

The new system has a number of features of special interest. First, by utilizing radio rather than wire lines, it eliminates the ofttimes prohibitive cost of installing and maintaining telephone lines to serve only a few widely separated subscribers.

Second, it benefits the telephone company by permitting the use of unattended exchanges for radiotelephone service as well as for regular wire line telephone service. Until now, all radiotelephone service has required the presence of an operator. With this new system, the telephone company's automatic base station, which receives calls from subscribers, connects directly with the unattended exchange via one of the regular 10-party subscriber line circuits.

Third, this new system uses specific tone sequences for dialing, so that it is practically impossible to receive a wrong number because of radio interference.

The new pushbutton system is easy to operate. Lifting the handset and depressing the push-to-talk button automatically connects with the base station and the local exchange. Then, it is just a matter of pushing the buttons in the proper sequence to get the exchange and party wanted.

North America to Europe Telephone Cable. The spectacular success of the first transatlantic telephone cable system, opened for service in 1956, has prompted the American Telephone and Telegraph Company (AT&T) to launch a new enterprise for construction of an undersea telephone cable system between North America and Europe.

Parties to the contract include the French Ministry of Posts, Telegraph and Telephones; the German Federal Ministry for Posts and Telecommunications; Eastern Telephone and Telegraph Company, and AT&T. The French and German agencies are responsible for telephone services within their respective countries. Eastern Telephone and Telegraph Company, a Canadian subsidiary of AT&T, now owns jointly with Canadian Overseas Telecommunication Corporation and the British Post Office a radio relay system from the United States to Sydney Mines, Nova Scotia, which will be used by the new system.

The new cable system will be of the same design as the first transatlantic link which connects the United States and Canada with England. A similar cable system now operates between the States and Alaska and another extending from California to Hawaii was opened for service recently. The new transatlantic system will consist of twin cables—one to carry speech west to east and the other to carry speech east to west. Each cable will contain built-in amplifiers situated about 40 miles apart.

The cable will be able to carry 36 simultaneous conversations; 13 of the circuits going to France, 13 to Germany, and the remaining 10 circuits reserved for extenson to other countries in Europe. The cables will cross the Atlantic between Newfoundland and the Brittany peninsula in France.

Over-the-Horizon Microwave Telephone. The first direct commercial telephone service between Italy and Spain was inaugurated on September 4, 1957, over the world's first over-the-horizon (O/H) microwave link to be put into regular commercial service, spanning the 230-mile gap between the Mediterranean islands of Sardinia and Minorca. Messages of greeting and congratulation were exchanged between His Excellency Camilo Alonso, Minister of Interior, speaking from Madrid, Spain, and His Excellency Bernardo Mattarella, Minister of Telecommunication, speaking from Rome, Italy.

The supply and installation of the equipment, as well as the propagation tests that proved the feasibility of the O/H system, were made by IT&T (International Telephone and Telegraph Corporation), and its associated companies FACE (Fabbrica Apparecchiature per Comunicazoni Elettriche Standard) and SIRTI (Societa Italiana Reti Telefoniche Interurbane) in Milan, and SESA (Standard Electrica, S.A.) in Madrid. The technical direction of the project was carried out by IT&T's central research laboratory in the United States, FTL (Federal Telecommunication Laboratories), Nutley, N. J. This is the first of a number of such systems being installed by IT&T in various parts of the world.

The terminals of the O/H link are located near Mahon, the principal town of Minorca, and Oristano on the west coast of Sardinia. Channels for six simultaneous telephone calls are available, with provision for 30 more, as required. Open-wire carrier or coaxial cable systems and radio link facilities furnish the necessary connections with the national telephone networks.

Fourteen years of intensive research established the techniques of tropo-

spheric forward-scatter, whereby microwave communication could be reliably established between points as far distant as 350 miles, and in 1953 work started on a link between Cuba and Florida whose bandwidth is sufficient to permit the transmission of both television and telephone simultaneously. This link, jointly and equally financed by IT&T and AT&T, was inaugurated in September.

The system works this way: radio beams are focused, much like the beam of a searchlight, from a 60-foot square transmitter antenna toward a receiving antenna located below the horizon. With the curvature of the earth blocking a direct path to the receiver, the signals travel outward in the layer of air surrounding the earth which is known as the troposphere. There are apparently sufficient irregularities in this air mass to cause some of the energy to be reflected or refracted downward. Only a minute portion of the microwave energy transmitted is received at the distant point, but this small amount is enough to make the system work.

Technically known as "tropospheric scatter propagation," the method employed emits large amounts of microwave energy in the direction of the receiving antenna located at a point beyond the horizon. Enough of this energy is collected by the receiver to permit useful and reliable communication. The scattering technique, not exclusively confined to use with the tropospheric layer, promises important changes in radio communication. The O/H technique is also receiving wide military application, such as in the "White Alice" communcation network in Alaska and the DEW (distant early warning) Line of radar outposts across Alaska and Canada, now being operated and maintained by IT&T's Federal Electric Corporation, and in the command communications network for SHAPE (Supreme Headquarters, Allied Powers in Europe), extending between northern Norway and eastern Turkey, which is being engineered and will be installed by IT&T's Standard Electric Corporation.

In the Cuba–Florida link, the essential difference between the earlier type of line-of-sight transmission and the over-the-horizon technique was in harnessing the microwaves' "scatter" effects. In line-of-sight transmission, signals are sent in a concentrated beam from transmitter to receiver. In the over-the-horizon communication, which employs high-power transmitters and high-gain antennas, the signals that "scatter" from the main beam are received through the use of "high-gain" antennas and amplified to become useful signals again.

The system also differs from others constructed or under construction in that it incorporates a frequency band broad enough to accommodate television and more than 100 telephone conversations at the same time. The conventional O/H system is narrow band and is capable of carrying only a limited number of voice or telegraph channels.

The main problem that faced IT&T was the engineering of tropospheric scatter propagation equipment that would be able to carry television and the many telephone conversations over the 185-mile route without appreciable loss in reliability. This was accomplished by increasing the bandwidth of the transmitters and receivers and by developing a suitable "dual and quadruple diversity" system.,

Engineers determined that the most feasible method was the relatively new one using "over-the-horizon" microwaves, and a task force designed the four dual-diversity-receiver sets, which operate in the 692-880 microwaves area.

The converter-amplifier, which accepts an FM signal and converts it to the 692-880 mc band suitable for "over-the-horizon" transmission, was also developed. A specially developed power amplifier increases the converter-amplifier's 10-watt output to the 10-kw level.

Annual Edison Amateur Award Nominations

The nation's 150,000 licensed amateur radio operators again will be honored in General Electric's (GE) annual Edison Amateur Award for public service. Nominations now are open for the 1957 trophy.

"Experience proves that as long as we are plagued with floods, tornadoes, hurricanes, and other mass and personal disasters, we can count on amateur radio operators to do their part in providing a wide variety of public services," said L. B. Davis, committee chairman for the award which is sponsored by GE's Electronic Components Division.

The principal winner will receive a trophy and $500 at a presentation banquet in Washington, D. C., in February 1958. Special citation winners are awarded plaques in recognition of individual public service. When occasion warrants, the judges award commendation certificates to radio amateurs participating in group activities such as hurricane and flood emergency communications.

As in past years, letters of nomination may be submitted by any individual or group on behalf of radio amateurs who have performed an outstanding public service during 1957. The nominations must include the amateurs' names, addresses, radio call letters, and full descriptions of the public services rendered. To qualify for the 1957 program, nominations must be postmarked not later than January 3, 1958, and mailed to the Edison Award Committee, General Electric Company, Owensboro, Ky.

Judges for the 1957 award will be Rosel Hyde, commissioner, Federal Communications Commission; E. R. Harriman, chairman, American National Red Cross; and G. L. Dosland, president, American Radio Relay League.

Mr. Davis said he is requesting honorary state chairmen who last year assisted in obtaining nominations to serve again. In most cases, the state chairmen appointed were state civil defense directors, chosen because of their close contact with radio amateurs serving in disasters.

"However, I want to emphasize that civil defense and disaster work is not the only public service that amateurs perform," said Mr. Davis. He referred to last year's winner, Mrs. Mary Burke, W3CUL, Morton, Pa., who has handled thousands of messages for servicemen overseas; the 1955 winner, R. W. Gunderson, W2JIO, New York, N. Y., who designs special electronics instruments enabling the blind to make their living in the growing field of electronics; and the 1953 winner, J. S. Surber, W9NZZ, Peru, Ind., who devotes 40 hours a week handling messages for weathermen at remote Arctic stations.

Operating Room Temperature Control and Death to Bacteria

An electronic control system that enables a surgeon to regulate temperatures in the operating room during surgery by remote control was unveiled recently at the American Hospital Association convention.

Without taking his eyes from the patient, the physician steps on a foot pedal beneath the surgery table which rings a bell on a telephone located on a control panel at the remotely located supervisory nurse's desk. His voice is picked up by a sensitive microphone located in the ceiling as he requests a temperature change.

From her desk, the nurse can instantly obtain the temperature in the operating room by pushing a button on a control panel and reading an indicator in front of her. She is able to reset the temperature to conform with the doctor's wishes immediately by turning a calibrated knob.

The system, developed by Minneapolis-Honeywell and known as a "Hospital-Master," gives a supervisory nurse complete control over heating and air conditioning in such critical areas as the operating room, obstetrical department, and psychiatric detention rooms.

Operating "brain" of the Hospital-Master is a five-foot panel attached to the nurse's desk. It contains pushbuttons, indicating lights, knobs, and a telephone. The intercommunications system normally employed between the surgery room and supervisory nurse is integrated with the panel.

The Hospital-Master is said to simplify, expedite, and reduce the cost of satisfying the widely varying temperature requirements in critical hospital areas.

In the operating room particularly, surgeons need indoor climate adjustments speedily during the course of an operation to protect the patient's health and also to clear the air of medicinal odors.

An ultraviolet lamp which sets up a barrier of death to bacteria, virus, and molds, has been developed by engineers of the Westinghouse Lamp Division.

Known as the Sterilamp (registered trade mark) *G10T5½*, the lamp produces a radiation which is about 100 to 1,000 times more effective in killing microorganisms than an equal amount of ultraviolet radiation from the sun.

The lamp is especially designed for use in homes, schools, and offices and is intended for insertion in heating and air conditioning ducts, according to E. G. F. Arnott, director of research for the Westinghouse Lamp Division. Tests have shown this high-output lamp to be 2½

times as potent as previous lamps of this size, and it is particularly effective in killing the influenza virus, Mr. Arnott reported. These tests have indicated, he said, that 80% of airborne virus and bacteria can be destroyed by inserting a single ultraviolet lamp in a heating or air conditioning duct.

One of the interesting facts about the new Sterilamp tube is the fact that in normal use the faster the movement of air past the lamp, the greater the ultraviolet bactericidal output of the lamp, Mr. Arnott explained. Another important advantage of the lamp is that it has a substantial deodorizing effect upon the air, making it ideal for use in window air conditioners and room heating units. The germ-killing action of the *G10T5½* Sterilamp tube should make it advantageous to commercial and industrial establishments in reducing absenteeism. This would also be true in schoolrooms and, in fact, in any public building where concentrations of people occur.

Elementary School Closed-Circuit Television

"Operation Shoestring," a closed-circuit television network costing less than $3,000, has been successfully employed during the past six months at Euclid Elementary School in Schenectady, N. Y., to enrich the regular school program.

B. F. Haake, assistant to the superintendent of schools in Schenectady, explained the name Operation Shoestring as follows: "Our past experience with closed-circuit television convinced us that any school could have such facilities for a very reasonable figure, and yet many of the school people we talked with were afraid to tackle a closed-circuit program because they thought it meant an investment of from $20,000 to $40,000. We wanted to show that a school could install a television system for as little as $3,000. Once teachers get their hands on the equipment, they can show the administrators numerous ways of using television to enrich and expand the school curriculum."

Using a General Precision Laboratory (GPL) classroom vidicon camera with interchangeable lenses, the Schenectady school system had its own employees install the cables which were connected to three used television sets in adjacent classrooms. "We picked up second-hand television sets for about $40 apiece," Mr. Haake explained.

The camera and a monitor were in one classroom and special lessons presented in that room were televised to three other classrooms. Costs were kept to a minimum by utilizing the school's motion picture sound amplifier to provide an independent sound system.

All that had to be done was pull the television cable and sound wire through some ventilators, clip them to wall moulding, attach one end to the GPL camera, the other to the sets, and the school was in business.

Fifth and sixth grade children have participated in the project. Special lessons presented included a library program aimed at stimulating reading and use of the library; science programs dealing with principles to flight, rock formations, pond life and nature study; a singing lesson involving French songs; and news telecasts.

Lessons were presented by children, regular teachers, and specialists. Erle Smith, Principal of Euclid School, emphasized the point that television provided a broader sharing with pupils of those teachers possessing special skills.

Schenectady school officials envisioned a plan whereby a school system containing several or many elementary school buildings could install closed-circuit television facilities in each building. Teachers with specialized training, such as resource teachers in art and science could extend their range of effectiveness by becoming "circuit riders of closed television circuits."

Normally these special teachers travel from building to building teaching one class at a time on a scheduled basis. This restricts their effectiveness; but if each school were equipped with television, the special teacher could carry his camera from school to school, plug it in on reaching a particular school, then teach three, four, or any number of classes at one and the same time. The shortage of specialists, particularly those in the field of elementary science, warrants adoption of techniques and equipment which will make it possible for those scarce teachers to teach as many children as possible.

The Schenectady Public School system, with an enrollment of 13,000 pupils in 18 elementary, 5 junior high, and 2 senior high school buildings, has been using open circuit television for the past three years as a means of teaching French, science, and industrial arts to elementary school children. They have also used closed-circuit television for high school instruction in mathematics, French, and chemistry.

Activities of Other Societies and Organizations

American Society of Mechanical Engineers

The president of a large engineering society said that the engineering profession is "bursting at the seams and will fly apart," unless steps are taken to analyze problems facing the profession and remedy the situation. W. F. Ryan, president of the 50,000-member The American Society of Mechanical Engineers (ASME), expressed his opinion during a luncheon address at the Fall Meeting of ASME which was held at the Hotel Statler, Hartford, Conn.

To help correct this situation, Dr. Ryan repeated pleas he has made throughout the year for support of a comprehensive detailed survey of the engineering profession, as proposed by Engineers Joint Council (EJC) and Engineers Council for Professional Development (ECPD). He added that a present appropriation by several engineering societies of $50,000 would "scratch the surface" of such a survey, but more time and money would be needed to complete it.

Only a handful of engineers bother with helping to further the professional aspects of engineering and less than one half of all practicing engineers belong to any engineering society. Most engineers know and care nothing about the code of ethics of their profession and reject the legal status given them, he said.

American Management Association

The American Management Association (AMA) recently announced the election of five new vice presidents and eleven new directors following board and membership meetings of the 25,000-member management educational organization.

The new vice presidents chosen to head AMA's operating divisions for the 1957-58 term are as follows: vice-president in charge of the insurance division, Frazier Wilson, manager, insurance division, United Air Lines; vice-president in charge of the international management division, A. L. Nickerson, president, Socony Mobil Oil Company, Inc.; vice-president in charge of the manufacturing division, M. C. Weaver, president, The Randall Company; and vice-president in charge of the marketing division, T. T. Miller, president, Polymer Chemicals Division, W. R. Grace & Company. K. S. McHugh, president, New York Telephone Company, was elected a vice-president at large.

Ten men were named to three-year terms (1957-1960) as directors: F. G. Atkinson, vice-president, R. H. Macy & Company, Inc.; R. M. Besse, executive vice-president, The Cleveland Electric Illuminating Company; P. J. Cupp, president, American Stores Company; A. B. Dick, III, president, A. B. Dick Company; E. M. Gordon, president, Towle Manufacturing Company; R. L. Jacobus, manager, insurance and pension department, Ford Motor Company.

Also, R. H. Lueck, vice-president, American Can Company; R. E. Olson, president, Taylor Instrument Companies; Ralph Presgrave, vice-president, J. D. Woods & Gordon, Ltd.; and G. E. Wallichs, president, Capitol Records, Inc.

Mr. Mueller was elected a director to complete the unexpired term, ending in 1958, of C. H. Ingram, vice-president and general manager, Weyerhaeuser Timber Company. Mr. Olson and Mr. Gordon also were elected to the AMA executive committee.

Re-elected as vice-presidents were the following men: vice-president in charge of the finance division, J. E. Kusik, vice-president–finance, The Chesapeake & Ohio Railway Company; vice-president in charge of the general management division, J. E. Jonsson, president, Texas Instruments, Inc.; vice-president in charge of the office management division, W. L. Crunk, general supervisor, sales offices, Reynolds Metals Company; vice-president in charge of the packaging division, C. L. Rumberger, vice-president, Research and Quality Control Division, H. J. Heinz Company; vice-president in charge of the personnel division, J. H. Taylor, manager, personnel administration department, The Procter & Gamble Company; and vice-president in charge of the research and development division, C. G. Suits, vice-president and director of research, General Electric Company.

Illuminating Engineering Society

K. M. Reid, senior illuminating engineer of the General Electric Company's Lamp Division, Cleveland, Ohio, became president of the Illuminating Engineering Society October 1 following his confirmation at the society's recent national technical conference.

Mr. Reid assisted the retiring president, M. N. Waterman, of the Westinghouse Lamp Division, in conducting the society's annual four-day conference which was attended by some 900 lighting engineers, designers and related professionals.

Others who were named to national and regional offices by the 8,800-member professional organization were J. B. Browder, Georgia Power Company, Atlanta, vice president; J. R. Chambers, Appleton Electric Company, Chicago, treasurer; J. D. Mitchell, Westinghouse Lamp Division, Chamblee, Georgia, director; and J. D. Whitnell, Arizona Public Service Company, Phoenix, also a director.

New regional vice-presidents elected for two-year terms were J. A. Banton, Tampa (Florida) Electric Company; A. E. Fleming, General Electric Supply Company, Salt Lake City; R. K. Lothrop, Southwestern Gas and Electric Company, Shreveport; C. C. Shotwell, Philadelphia (Pa.) Electric Company; and J. C. Wilson, J. A. Wilson Lighting and Display, Ltd., Toronto.

Present and Future Home Lighting

A totally new concept in decorative lighting, featuring "the most beautiful lamps in the world," was revealed recently by General Electric's (GE) Miniature Lamp Department, Nela Park, Cleveland, Ohio.

Called "Lighted Ice," the new lamps not only are "beautiful to look at" both lighted and unlighted, but also burn cooler than other decorative lamps. The complete line features six glamorous new colors: emerald, garnet, pearl, ruby, topaz, and turquoise.

The new lamps are round and approximately two inches in diameter. They are covered with bagette-shaped crystals which diffuse and transmit light in all directions and sparkle "like colorful gems with thousands of facets."

"Lighted Ice" lamps will add "shimmering beauty" to a wide variety of applications, wherever unusual effects are desired, according to the marketing manager.

They are multiple burning lamps (when one burns out the others stay lighted) designed for use on 120-volt household circuits. Their candelabra screw bases will fit into regular C7½ Christmas lamp or other candelabra screw base sockets. They may be used outdoors when installed in proper equipment.

Each lamp is colorfully packaged in its own wrapper. There are six lamps of one color per carton and two cartons of each color in a 72-lamp outer case. Each 72-lamp assortment contains a free spectacular display which can be lighted by a specially designed string set included in the package.

The future lighting of a room may be accomplished by the request, "Turn on the windows, it's getting dark." This is the way the housewife of tomorrow may ask another member of the family to turn on the lights in the home when dusk approaches, according to Westinghouse scientists.

In their constant research in the field of electroluminescence, a method by which specially coated sheets of glass can be made to produce light, Westinghouse scientists are experimenting with producing transparent phosphors. This means that a phosphor can be sandwiched between two sheets of glass which have a coating that conducts electricity during the day, this glass would allow daylight to come through and permit the viewer to look out (or in) in the customary manner. At night, however, electricity would be applied and the transparent phosphor would emit light.

According to the director of research of the Westinghouse Lamp Division, the use of these transparent electroluminescent windows would provide the effect of having daylight 24 hours a day. It was stated that electroluminescent panels (called Rayescent lamps) already are being produced for commercial use. In about two years their use will become widespread. However, the transparent electroluminescent windows will take longer to develop with a probable wait for the 1960s before their use becomes practical.

Chameleon-like, color changing panels, no thicker than window glass, can be used to line and light an entire wall or ceiling, and to give off light equivalent to that in a modern well-lighted office. An area light source, electroluminescent lamps are basically a two dimensional source.

By freeing light from the confines of point or line sources such as incandescent or fluorescent lamps, electroluminescent lighting promises to spark totally new concepts of lighting, it was explained. Light in the future will be part of the construction of walls and ceilings. And because electroluminescence is not restricted to flat planes, light may go into the construction of domes, balustrades, and other architectural designs.

"Helitron" Tube Developed at Stanford

An ingenious new electronic tube that permits instantaneous radar tuning over a prodigious range of microwave radio frequencies has been developed at Stanford University, it was revealed in a recent release from the News and Publications Service of the school, located in Stanford, Calif.

In addition, the new "helitron" tube has a multitude of other potential uses in f-m, uhf, and color television, aircraft communications, and radio telephone systems.

Its inventor, Prof. D. A. Watkins of Stanford's Electron Tube Laboratory, first described the tube at a recent research conference in Berkeley, Calif. His research assistant was George Wada, a graduate student. Their work was supported by the Office of Naval Research, the U. S. Air Force, and the U. S. Army Signal Corps.

Essentially, said Dr. Watkins, the helitron is a major improvement over the "backward-wave" oscillator developed in 1953. Both do the same job, but the helitron does it better.

The helitron is far simpler, easier to build, and uses power five times more efficiently. It will cost about half as much as the backward-wave oscillator to manufacture, and will save up to half a ton of radar equipment weight in a large airplane.

Helitrons can be designed to operate as low as 200 or as high as 10,000 mc or more, Dr. Watkins said. The tube has a "two-to-one tuning range with only a two-to-one change in voltage."

This means that a helitron designed for a lower limit of 2,000 mc could be tuned instantly to any frequency between 2,000 and 4,000 mc simply by making a proportional change in voltage. A lower limit of 4,000 would permit tuning from 4,000 to 8,000 mc.

Radar frequencies are normally in the 1,000 to 10,000 mc range. By contrast, the entire tuning band of an ordinary household radio covers only 1 mc.

Before the invention of the backward-wave oscillator and the helitron, similar radar frequency variations could be made only by the use of elaborate equipment and time-consuming mechanical adjustments. Mere voltage regulation will do it now.

The helitron is a slim glass vacuum tube about one foot long. In accordance with the "scaling law" of microwaves, higher frequency tubes would be smaller, lower-frequency tubes larger.

The tube employs an electon beam, has a stainless steel and molybdenum inner structure, and an insulator core of four sapphire rods. Commercial manufacture of helitrons by an electronics firm is expected to begin shortly.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

L. P. ALFORD AND THE EVOLUTION OF MODERN INDUSTRIAL MANAGEMENT. By W. J. Jaffe. New York University Press, Washington Square, New York 3, N.Y., 1957. 366 pages, 6 by 9½ inches, bound, $5. An historical account of Alford's contribution to the development of scientific management, based on his letters and unpublished manuscripts as well as on his published material and known activities. Alford's many interests resulted in the development of principles governing specialization, standardization, leadership and organization, production planning and control, materials handling, quality control and inspection, covering human as well as physical problems. The breadth of his character and activity is demonstrated by the appended bibliography of his writings.

ANALYTICAL DESIGN OF LINEAR FEEDBACK CONTROLS. By G. C. Newton, Jr., L. A. Gould, J. F. Kaiser. John Wiley & Sons,

Inc., 440 Fourth Ave., New York 16, N.Y., 1957. 419 pages, 5¾ by 9¼ inches, bound. $12. The phrase "analytical design" is identified by the authors as the design of control systems by application of the methods of mathematical analysis to idealized models which represent physical equipment. Starting with the system specifications, the authors describe the input, the disturbances, and the desired response, including a statement of the basis on which the system performance will be judged. Separate chapters discuss the minimization of various errors which represent the performance index. An application of the analytical theory to a practical problem is fully discussed, and a working example of graphical procedures is also presented.

BEHAVIOUR OF METALS AT ELEVATED TEMPERATURES. Published 1956 by Philosophical Library, Inc., 15 E. 40th St., New York 16, N.Y. 122 pages, 5¾ by 8¾ inches, bound. $6. This volume, based on lectures presented at the Institution of Metallurgists 1956 Refresher Course, will be useful to the metallurgist as well as to the engineer engaged in high temperature work. The effects of high temperatures on engineering properties of metals are covered as well as kinetic heating, high temperature steels, and the effects of high temperatures on air frame structures and guided missiles.

BOUNDARY CONTROL AND LEGAL PRINCIPLES. By C. M. Brown. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1957. 275 pages, 5¾ by 8¾ inches, bound. $7.50. This is a discussion of the legal elements and terms that control what and where boundaries of real property are. Chapters one and two deal with deeds and methods of transferring ownership; chapters three through eight with the legal determination of exact location; and the last two chapters with making the survey and writing deeds. Riparian and littoral rights and Federal mining claims are treated.

CORROSION AND WEAR HANDBOOK FOR WATER-COOLED REACTORS. Edited by D. J. De Paul. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1957. 293 pages, 7¾ by 10½ inches, bound. $6. The first part of this handbook includes general discussions on the nuclear reactor plant and its relation to conventional power plants, considerations in choosing materials, fundamentals of corrosion and wear, and water technology. The second part provides tabulated data and detailed reference information on methods of testing and on the corrosion and wear resistance of various materials in different environments. The last part deals with special problems such as crevice, stress, and intergranular corrosion, system corrosion deposits, wear, and manufacturing problems. The book is one of a series sponsored by the Naval Reactors Branch of the Atomic Energy Commission.

DICTIONNAIRE FRANÇAIS-ANGLAIS DES TERMES RELATIFS À L'ÉLECTROTECHNIQUE, L'ÉLECTRONIQUE, ET AUX APPLICATIONS CONNEXES. By H. Piraux. Éditions Eyrolles, Paris, France, 1956. 168 pages, 6¼ by 9¼ inches, paper. 960 francs. This new compilation covers all aspects of electrical engineering with particular attention to both theoretical and practical electronics: radio, television, radar, hyperfrequencies (microwave region), photoelectricity, etc. Many words and terms are included from related fields, such as acoustics, optics, plastic materials, machinery, and nuclear physics. The English terms conform to the recommendations of the American Standards Association and the British Standards Institution.

FUNDAMENTALS OF ELECTRON DEVICES. By K. R. Spangenberg. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1957. 505 pages, 6½ by 9¼ inches, bound. $10. This introductory text emphasizes the physics of electron devices and, also, the similarities rather than the differences between tubes and transistors. About 60% of the book is devoted to the operating characteristics of electron devices, the remainder to their circuit applications. A set of problems is provided at the end of the book along with a list of some 200 references keyed to the text.

AN INTRODUCTION TO REACTOR PHYSICS. By D. J. Littler, J. F. Raffle. Pergamon Press, 122 E. 55th St., New York 22, N.Y., second edition, 1957. 208 pages, 5¾ by 8¼ inches, bound. $5.50. A presentation of the calculations used in evaluating the critical size of a gas-cooled, graphite-moderated, natural uranium reactor of the type used in the nuclear energy power program in Great Britain. The physics essential for the understanding of the construction of this and other types of reactors are covered. In this edition, the text has been simplified and rearranged, and numerous additions and corrections have been made as a result of the release of data at the Geneva Conference in 1955.

THE j OPERATOR FOR ELECTRICAL ENGINEERS. By Philip Kemp. St. Martin's Press, Inc., 103 Park Ave., New York 17, N.Y., 1957. 135 pages, 5½ by 8¼ inches, bound. $4.25. The author's intent in this small book is to demonstrate the fact that the j operator, although a mathematical concept, is readily applicable to electrical engineering problems without any special knowledge of the mathematics involved. Once its use is learned, the solution of many problems in the following subject fields can be considerably simplified: impedance in series circuits; admittance in parallel circuits; polar co-ordinates; and transformers, a-c generators, and motors. Several other similarly usable operators are also briefly treated.

MAGNETOHYDRODYNAMICS. Edited by R. K. M. Landshoff. Stanford University Press, Stanford, Calif., 1957. 115 pages, 6¼ by 9½ inches, bound. $4. Magnetohydrodynamics is the study of how magnetic fields influence and are influenced by ionized gases. In this book, an outgrowth of a symposium sponsored by the Missile Systems Division, Lockheed Aircraft Corp., in 1956, some of the theoretical and experimental work done in the field is presented in a group of papers by various authorities. Subjects of the papers include magnetically driven shock waves, penetration of a shock wave into a magnetic field, liquid sodium instability, and the hydromagnetic wave guide.

MICROPHOTOGRAPHY. By G. W. W. Stevens. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1957. 326 pages, 6 by 9¼ inches, bound. $8.50. This book brings together the widely scattered published information important for the practice and application of microphotography, giving sufficient detail on apparatus and working methods to enable photographers to produce good microphotographs. The first part of the book deals with methods of production: sensitive materials, processing, objectives, focusing methods, the camera, the original, image formation, and methods of control to ensure sharpness. The last part of the book deals with applications: the production of reticles, copying documents, and techniques for scientific investigations.

NUCLEAR CHEMICAL ENGINEERING. By Manson Benedict, T. H. Pigford. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1957. 594 pages, 6 by 9¼ inches, bound. $9.50. This volume describes the materials of importance in nuclear reactors and the processes which have been developed to concentrate, purify, and separate these materials. After two introductory chapters the following topics are considered: fuel cycles in thermal nuclear reactors, production of uranium feed materials, solvent extraction of metals, properties of irradiated fuels, separation of reactor products, principles and methods of isotope separation for both light and heavy elements.

NUCLEAR POWER YEARBOOK, 1957. Published 1957 by Rowse Muir Publications, Ltd., London, England. 500 pages, 5¾ by 8¾ inches, bound. 42s. Contains brief review articles on advances in the nuclear power field, a country-by-country directory of atomic energy authorities, a section on isotopes, a "Who's Who" in British nuclear energy, and a buyer's guide to materials, plant, services, and instruments produced by British firms.

POLYETHYLENE. By T. O. J. Kresser. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y., 1957. 217 pages, 5¼ by 7¾ inches, bound. $4.95. A concise description of the basic chemistry, manufacture, processing, and applications of polyethylene. Coatings, film, pipe, coated wire, moldings, and other applications are discussed. The volume is the first in a new series of short books intended to familiarize engineers and manufacturers with the potentialities of the various types of commercial plastics.

PROCEEDINGS OF THE CONFERENCE ON OPERATIONS RESEARCH, COMPUTERS, AND MANAGEMENT DECISIONS. Sponsored and published in 1957 by the Operations Research Group, Department of Engineering Administration, Case Institute of Technology, University Circle, Cleveland 6, Ohio. 97 pages, 8½ by 11 inches, paper. $5. As stated in the foreword, "Of particular interest to management are the economical design of effective data processing systems and the use of computers in decision making and control. In these connections, there are problems of installation and operating costs, data collection methods, research utilization of machine time, etc." The 10 papers included in this volume deal with some general or special aspect of the aforementioned designated field of interest, with the intent of exploring some of the potentialities of operations research and electronic computer facilities.

RADIATION SHIELDING. By B. T. Price and others. Pergamon Press, 122 E. 55th St., New York 22, N.Y., 1957. 350 pages, 6¼ by 9¼ inches, bound. $10. This book is concerned with the basic physics of radiation and with practical considerations in the engineering design of shields for reactors, betatrons, synchrotrons, and linear accelerators. In the design section, the book deals with heat generation in shields, concrete shields, metal-hydrogen bulk shields, and shielding for radioactive materials during transport. The physics of radiation is covered in chapters on gamma-ray attenuation, neutron physics, and neutron attenuation in thick shields. Selected references are listed after each chapter.

SYNTHESIS OF PASSIVE NETWORKS. By E. A. Guillemin. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1957. 741 pages, 5¾ by 9¼ inches, bound. $15. Assuming a good understanding of essential mathematics and basic circuit analysis, the author presents the fundamental theory of the subject matter, general methods of synthesis, and sufficient examples to clarify the presentation. The detailed treatment covers both the approximation problem and the realization techniques. As an essential tool in a broad field of engineering activity, the subject is sufficiently developed to prepare the student independent work. A subsequent volume will cover "special problems in network synthesis."

UNDERGROUND SYSTEMS REFERENCE BOOK. By the Transmission and Distribution Committee of the Edison Electric Institute. Edison Electric Institute, 420 Lexington Ave., New York 17, N.Y., 1957. Various pagings, 8½ by 11½ inches, bound. $12.50. The first revision of a work originally published in 1931, this volume is a comprehensive and practical study of the best practices in the design, construction, operation, and maintenance, of power cable systems. Its 15 chapters prepared by a staff of 134 engineers cover thoroughly cable and cable insulation, bulk power systems, underground radial and loop systems, street lighting systems, cable joints and terminations, testing and fault location, corrosion, safety, and related subjects. A detailed subject index is included.

WORK SAMPLING. By R. M. Barnes. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., second edition, 1957. 283 pages, 5¾ by 9¼ inches, bound. $7.95. An analysis of work sampling for establishing time standards for manual tasks is presented in this reference and guide to work sampling studies. The book covers the results of research in the field from Tippett's fundamental work on the ratio-delay method of measuring idle time. It shows how to apply measurement techniques in an individual office or factory, and it includes a bibliography and case histories of actual situations.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

EXTERNAL CARDIAC PACEMAKER-DEFIBRILLATOR. A simple electronic instrument which restores normal heartbeat in cases of cardiac arrest has been designed by the Air Force's Aero Medical Laboratory. The device is described in a report released to the public through the Office of Technical Services (OTS), U. S. Department of Commerce. The instrument is effective in restoring cardiac function after cardiac standstill, where the heart has stopped contracting, and ventricular fibrillation, where individual muscle fibers of the heart are contracting asynchronously. The pacemaker-defibrillator can also increase the output of a feebly beating heart by forcing more complete contraction and, if needed, increasing heart rate. The device alleviates the necessity of thoractomy, or opening the chest, and manual heart massage. It is described as simple, compact, safe, and reliable, and ideally suited for emergency use in surgical or experimental situations. Included in the report are discussions of the history and physiology of pacemaking and from cardiac standstill internal defibrillation. The theory, design, and use of the pacemaker-defibrillator are described in detail. The illustrated volume, *PB 121888*, T. F. McGuire, S. C. White, D. A. Rosenbaum, Wright Air Development Center, U. S. Air Force, December 1956, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D.C. It contains 29 pages, price 75¢.

AIR CONDITIONING-REFRIGERATING DATA BOOK, DESIGN VOLUME. This well-recognized handbook of the air conditioning and refrigeration industry is a fundamental tool for those active in design, research, reference, engineering, instruction, consultation, and development. Sponsored by 44 experts in the industry, the 10th Edition was written by eight associate editors, each selected for particular eminence in his field. This volume, 85% revised, includes authoritative information on physical data, application design, basic equipment, auxiliary and self-contained units, operation, codes, standards, abbreviations, symbols, definitions, theory, engineering, and refrigerants. The 800-page text is augmented by more than 400 charts and diagrams, plus 117 pages of charts and tables, to provide the fundamental facts upon which the companion Applications Volume is based. Included for the first time are: Common-Measure-to-Metric Conversion tables; list of foreign and domestic air conditioning and refrigeration associations, the new American Society of Refrigerating Engineers (ASRE) industry-approved Refrigeration Numbering System, and cross-referenced listing of United States and foreign trade names for refrigerants linked with corresponding ASRE designations. Providing an easy-to-use reference source, the Refrigeration Classified Setion in the back of the text contains listings of manufacturers of components and assembled units of refrigeration equipment. This limited edition is available by writing to the Data Book Sales Manager, American Society of Refrigerating Engineers, 234 Fifth Ave., New York 1, N.Y. Postage-paid prie: $10 in the U.S.A. and $10.50 in foreign countries.

FM STATIONS IN THE UNITED STATES AND CANADA. A booklet compiled for *Audiocraft* magazine by Bruce Cramer gives information for each station, including city, call letters, channel number, frequency, power, antenna height, latitude, longitude, and network affiliation. "FM Stations in the United States and Canada" may be obtained for 50¢ by writing to: FM Stations Up-To-Date, *Audiocraft* Magazine, The Publishing House, Great Barrington, Mass.

ENGINEERING MANPOWER: HOW TO IMPROVE ITS PRODUCTIVITY. A special report for management prepared by a group of nine students at the Graduate School of Business Administration of Harvard University. Recognizing the current problem of the shortage of engineers, the objective of this research report is to suggest areas and ways in which industry can improve the productivity of its present engineering manpower. The report is divided into two sections: Survey of Industry Practices and Policies and Conclusions and Suggestions. A bibliography is included. Published by Engineering Management Reports, P. O. Box 161, Cambridge 38, Mass., price: $18.50.

FLIGHT INFORMATION MANUAL. Contained in the Flight Information Manual of the Civil Aeronautics Administration (CAA), U. S. Department of Commerce are 88 pages of helpful information for the pilot. The manual is for sale at the U. S. Government Printing Office, Washington 25, D. C., for 50¢. A once-a-year publication, the Manual is useful to all pilots because of the important safety information it contains. New information included in vol. 11 includes a series of sketches showing various systems of approach lighting at airports throughout the country, especially the national standard configurations; definitions of Restricted, Prohibited, Caution, and Warning Areas over which flying is restricted; radar weather advisory service—what it is, who can use it, and how to use it; information on what the pilot should do in emergencies involving an aerial attack; and a description of the Washington, D. C., high density zone around the airport, along with flight rules to be followed while in the area. Since the *Airman's Guide*, published by the CAA every two weeks, contains a listing of all airports each quarter, the Manual omits its listing of airports. The Guide also carries a radio facility listing every other issue, and this has been omitted from the Manual. There are other helpful items in the Manual, including information on the National Search and Rescue plan; good operating practice; revisions of air traffic rules; and a complete descriptive rewrite of Federal Airways Lighting Aids.

U.S. RESEARCH REACTORS. Released by the U.S. Atomic Energy Commission. The 75-page book, illustrated with 116 drawings, photographs, diagrams, and charts describes more than 30 research reactors, now in operation or under construction. The reactors are grouped according to major types. One or two examples of each are described at length as typical. Features of others are illustrated and significant data given for all. Cost information is furnished for most of the research reactors, including analysis of the relation between the initial cost of the reactor itself and total costs incurred to make it useful. The annual cost of operating a research reactor—items such as salaries of supervisory and operating staff, heat and utilities, health physics service, maintenance, insurance, fuel and amortization—may range from as low as $15,000 per year for a fractional watt laboratory reactor to well over $200,000 per year for a 1,000-kw pool reactor. Special facilities may cost nearly as much as the reactor and entail a comparable annual operating expense. The booklet contains chapters on light-water moderated reactors (pool and tank types), heavy-water moderated reactors, graphite moderated reactors, homogeneous reactors, and reactors for safety research. It also has a brief glossary of reactor terms, and a list of research reactors built, under construction, or planned in the United States, including those intended for foreign locations. Prepared for scientists, engineers, and administrators, the booklet (paper bound) may be purchased for $1.50 from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

STEREOPHONIC SOUND. By N. H. Crowhurst. Although primarily written for high-fidelity (hi-fi) enthusiasts interested in obtaining the most realistic results in home audio reproduction, "Stereophonic Sound" will be welcomed by anyone concerned with sound reproduction. The book provides all the information the hi-fi fan needs to add this new dimension to his listening pleasure. In an easy, interesting style the author explains the theory of stereophonic sound; the difference it can make in listening pleasure; what goes into making it successful: various systems available or likely to be available. He covers such systems as binaural, two- and three-channel stereophonic, stereosonic, coded-stereophonic, and the use of these systems with radio, disc, tape, and other "media." This information is applied to selection and placement of speakers for the best home stereo reproduction. Price: $2.25, John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y.

RECOMMENDED PRACTICE FOR REPAIR WELDING AND FABRICATION WELDING OF STEEL CASTINGS. This manual replaces an earlier publication entitled "Recommended Practice for the Welding of Steel Castings" first issued by the Steel Founders' Society of America (SFSA) in 1951. The Steel Foundry Research Foundation (SFRF) sponsored and directed the necessary research for the preparation of the new manual at Battelle Memorial Institute under the guidance of C. W. Briggs, research director of the SFRF. Publication, and subsequent distribution, was assigned to the SFSA. The 1957 manual incorporates the many developments in welding procedure since 1951 and features what is probably the most comprehensive listing of the American Welding Society's classified mild steel and low alloy electrodes published to date. Divided into three sections, the manual covers welding methods, electrodes, and recommended welding procedures for carbon steel and low alloy castings with each general alloy series indexed for quick reference. The manual is a valuable guide to both producers and users of steel castings who make use of the economical cast-weld technique or who fabricate larger structures employing composite-fabrication by means of which steel castings are welded to wrought steel. It also serves as a guide for the repair or field modification of cast and wrought steels. Copies are available at 50¢ each from the Steel Founders' Society of America, 606 Terminal Tower Bldg., Cleveland 13, Ohio.

WIRING MANUAL FOR HOME AND FARM. How to plan safe, reliable wiring systems for the growing lighting, appliance, and power loads of modern homes and farms is fully explained in the "Wiring Manual for Home and Farm," published by McGraw-Hill Book Company in November. The author, A. C. Bredahl, is director of technical services of general advertising, Westinghouse Electric Corporation, Pittsburgh, Pa. Easy-to-follow directions are given for analyzing electrical requirements and for planning a wiring system that insures efficient, economical service. Step-by-step procedures are supplied for planning and sizing each phase of the wiring system for electrical equipment, appliances, and lighting. Three degrees of levels of electrification for the home are suggested in the manual and each is illustrated by practical example. Thus, the manual can be helpful for planning virtually any kind of wiring job—minimum acceptable, standard, deluxe. In addition, the manual covers the many new uses of electricity on the farm. Included are procedures for planning the all-important systems of "outside electrical distribution." Tables and other useful reference material help the reader easily determine such information as the required number of electrical circuits and their sizes, based on the floor area of a home and major electrical appliances used.

WELDING HANDBOOK. The American Welding Society announces that the newly published first section of the Fourth Edition of the Welding Handbook has been approved by the New York Public Library for display in its Technical Book of the Month Exhibition. Each month the New York Public Library selects what it considers the best of the technical books published during the month. These books are prominently displayed in the science and technology section of the library. The first section of the five-volume Welding Handbook contains 560 pages, 420 illustrations, and 86 or more tables. It deals with the fundamentals of welding and its 11 chapters contain: standard welding terms and their definitions, engineering tables, welding metallurgy, properties of welded joints, thermal and mechanical treatment of weldments, design of welded joints, estimating costs, inspection, mechanical testing of welds, statistical control and safe practices. Subsequent sections of the Handbook will cover: welding processes; miscellaneous metal-joining, cutting and maintenance processes and practices; metals; and finally, applications of welding. Copies may be obtained from the American Welding Society, 33 W. 39th St., New York 18, N. Y. at a list price of $9 per copy.

"I Am Ambitious Of Your Esteem"

Captain John Paul Jones:

To the Countess of Selkirk, in 1778, Paul Jones wrote ". . . I am ambitious of your esteem and friendship, and would do anything, consistent with my duty, to merit it."

After his men of the "Ranger" had commandeered the Selkirk's silver, Jones had privately promised to return it. Buying it from his crew for 140 English pounds, he returned the silver to the Countess in 1784. The Captain kept his word and won her lifelong esteem.

For more than a century, Kerite has been ambitious of your esteem—by building the most lasting cable yet known. And more than three generations of Kerite craftsmen have given of their inherited skill and craftsmanship to assure the long life and service of Kerite Cable. The Kerite Cable Company takes pride in the fact that their product is chosen by buyers of integrity to safeguard installations around the world.

The value and service life of a product can be no greater than the integrity and craftsmanship of its maker.

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INDUSTRIAL NOTES

New Subsidiary. The Utica Wire Corporation, Derby, Conn., has joined Viclad Industries, Inc., P.O. Box 9938, Pittsburgh 33, Pa., as its newest subsidiary. The Utica Wire Corporation is a drawing mill specializing in fine tinned wires single end, bunched, and concentric stranding of wires from size 40 gage down to size 26 gage. Monthly capacity is 100,000 pounds.

Instrumentation Van. The Grand Central Rocket Company has placed a contract with Era Engineering, Inc., 1009 Montana Ave., Santa Monica, Calif., for the assembly and checkout of an instrumentation van. The van is to be used at one of the remote static rocket motor firing areas and will house electronic recording and pickup instruments, a master fire control panel, and act as a central communication center for the test area. The master fire control panel was developed by Era Engineering, Inc., especially for the static testing of rocket motors. Its specific functions are to turn on recorders, cameras, calibration signals, the rocket motor, and then to turn off successively the same pieces of equipment. In case of interruption of the test, it is possible to stop the sequence operation and automatically to instigate calibration checks before turning off the equipment.

Bonding and Potting Service. Bacon Industries, Inc., has announced the addition of a bonding and potting service to their already well-known specialty rubber molding services. This bonding and potting service is directed toward the gyroscope and other precision instrument manufacturers in the electronics field who realize that the production of consistently high quality instruments requires quality components manufactured to rigid specifications. Correspondence outlining your problems in the bonding and potting fields should be addressed to Mr. Eldon Fay, Sales Manager, Bacon Industries, Inc., 192 Pleasant St., Watertown 72, Mass.

Cryogenic Development. The rapidly expanding field of cryogenics (the science of cold) now has a remarkable new tool which was developed by Linde Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N. Y. A portable liquid nitrogen refrigerator for laboratory and practical use in science and industry was unveiled recently. It is believed that the new refrigerator, designated *LNR-25B*, will find immediate use in such fields and industries as medical and pharmaceutical research, storage and transportation, chemical laboratories and plants, food processing, metalworking, electronics, and agriculture.

Closed Circuit TV Detects Shoplifting. The latest of the stores throughout the country to join the electronic war on shoplifting losses, is Gimbels, New York City, where a number of television cameras have been installed. These department store television systems are manufactured by Dage Television Division, Thompson Products, Inc., 65 N. 2nd Ave., Beech Grove, Ind. The typical television detective consists of a camera with four lenses in a turret mounting. It has a motor driven housing. It pans, tilts, takes long, medium, and closeup shots. Installed on the ceiling, it can be turned and raised or lowered, all by remote control from an office in the store's protection bureau. No extra lighting is necessary. Any person can operate the equipment with a few days' training.

New Gertsch Sales Office. To better serve the expanding northern California market, the establishment of a northern California sales office has been announced. The new office, located at 11761 Los Arboles, Sunnyvale, Calif., will be headed by R. T. Cushman.

New Electrical Contact Company. Contacts Incorporated, the first company in the East to make electrical contacts exclusively, has been organized in Wethersfield, Conn. President of the new corporation is R. W. Spellman, and K. L. Emmert is vice-president and chief engineer. For further information, data, or quotations, write Contacts Incorporated, 1100 Silas Deane Hwy., Wethersfield, Conn.

Production Time Savings. Hi-Fonic Music Systems, Inc., Palo Alto, Calif., has found that the use of a new type of screw-holding screw driver has resulted in savings of more than 50% in production time for assembly involving hard-to-reach places.

The screw-holding screw driver, which is made by The H.J.J. Company, 268 Marlow Drive, Oakland, Calif., provides a quick, sure way to hold a screw in position. As the assembler pushes forward, tiny twin bits expand inside the slot of the screw. The screw will not be released until it is firmly seated in the thread.

New Manager. The appointment of R. S. Mandelkorn as Manager of Operations for the Lansdale Tube Company, a Division of Philco Corporation, Lansdale, Pa., has been announced.

(Continued on page 20A)

first in Performance Reliability and Quality

Kepco

the most complete line of POWER SUPPLIES

TRANSISTORIZED V.R.P.S.*

- **REGULATION** (for line or load) 0.03% or 0.003 Volts (whichever is greater)
- **RIPPLE** 3 mv. rms
- **RECOVERY TIME** 50 microseconds
- **STABILITY** (for 8 hours) 0.03% or 0.003 Volts (whichever is greater)
- 0.005% resolution with 10 turn voltage control.
- Continuously variably output voltage without switching.
- External overload and short circuit protection included.
- Either positive or negative can be grounded.
- Units can be series connected.
- Suitable for square wave pulsed loading.
- Power requirements: 105-125 volts, 50-400 cycle.
- Terminations on front and rear of unit.
- High efficiency.
- Low heat dissipation.
- Compact, light weight.
- Color: grey hammer tone.
- Suitable for bench or rack use.
- Voltmeter and ammeter provided.

*VOLTAGE REGULATED POWER SUPPLIES

Model	Output Volts	Output Amps.	Output Impedance Ohms DC-1 KC	Output Impedance Ohms 1 KC-100 KC	Rack Mount W	Rack Mount H	Rack Mount D
SC-32-0.5	0-32	0-0.5	0.02	0.2	19"	3½"	11"
SC-32-1	0-32	0-1	0.01	0.1	19"	3½"	11"
SC-32-1.5	0-32	0-1.5	0.01	0.1	19"	3½"	11"
2SC-32-1.5 DUAL OUTPUT	0-32	0-1.5	0.01	0.1	19"	7"	11"
SC-32-2.5	0-32	0-2.5	0.01	0.1	19"	3½"	11"
SC-32-5	0-32	0-5	0.005	0.05	19"	5¼"	13"
SC-32-10	0-32	0-10	0.001	0.01	19"	8¾"	13"
SC-32-15	0-32	0-15	0.001	0.01	19"	10½"	13"
2SC-100-0.2 DUAL OUTPUT	0-100	0-0.2	0.1	1.0	19"	5¼"	11"
SC-150-1	0-150	0-1	0.05	0.5	19"	5¼"	13"
SC-300-1	0-300	0-1	0.1	1.0	19"	8¾"	13"

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INDEPENDENCE 1-7000

KEPCO OFFERS MORE THAN 120 STANDARD VOLTAGE REGULATED POWER SUPPLIES COVERING A WIDE RANGE OF MAGNETIC, TRANSISTOR AND TUBE TYPES. MOST MODELS AVAILABLE FROM STOCK. SEND FOR BROCHURE B-581

Model
SC-32-0.5
SC-32-1
SC-32-1.5
SC-32-2.5

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Industrial Notes

(Continued from page 18A)

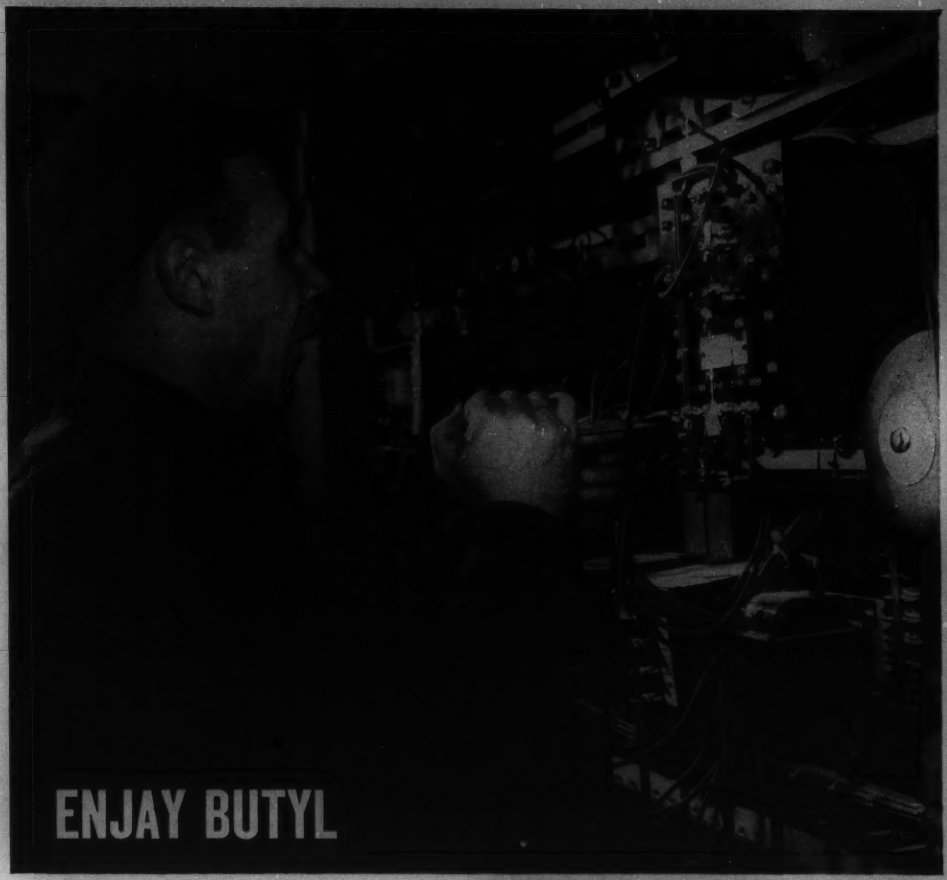
Production of High Voltage Recloser. An automatic circuit recloser for 46-kv maximum service application has been announced by the R&IE Equipment Division of I-T-E Circuit Breaker Co., 1935 Jones St., Greensburg, Pa. Interrupting ratings have been established at 4,000 amperes, rms symmetrical, for 34.5 kv, and 3,000 amperes, rms symmetrical, for 46 kv. Continuous current ratings are 400, 280, 140, and 100 amperes. The cycle instantaneous tripping of transient faults, followed by 25 cycle reclosing with 1, 2, or 3 inverse-time operations provides the same low-cost improvement of service reliability at these higher voltages that has distinguished recloser performance at distribution voltages. Production has started and test data or other information is available on request.

Generators for Niagara. An order for thirteen 167,000-kva waterwheel generators for the Niagara power project has been awarded to the Westinghouse Electric Corporation by the New York State Power Authority. The units represent the largest single order of its kind ever placed in the United States. The waterwheel generators are being built by the Westinghouse Electric Corporation's East Pittsburgh, Pa., plant.

Photo Comparator Designed and Built. A photo comparator has been designed and built by Greer Hydraulics, Inc., New York International Airport, Jamaica 30, N. Y. to detect minute particles of contaminant in high pressure gases. Originally developed as a component in the test stands for checking out aircraft engines, the unit is now being made available independent of the testing machines. The device can be used to check the operation and efficiency of filters, dryers, separators, and other similar instruments when used with transparent fluids. Complete information may be obtained from the company.

U. S. Distributor of Automatic Chemist. This apparatus performs the work of a skilled chemist in the continuous analysis of a chemical process during manufacture. The "Titromatic Analyser," as the apparatus is called, is connected to the main plant stream and at regular intervals a measured quantity of the solution being manufactured is fed to a reaction vessel. After dilution with water, titration with a standard reagent begins and continues until the solution has been completely neutralized. The amount of reagent used is determined by an "electric eye" which seeks and finds the level of the reagent, and in so doing, records the volume used on a recorder chart. In the meantime, the reaction vessel is emptying itself and the whole process starts again. The Titromatic Analyser is made available in the United States by the Instrument Division, Robertshaw-Fulton Controls Company,

(Continued on page 22A)



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Performance! Versatility! Economy! In all three, Enjay Butyl is the world's outstanding rubber value. In a wide variety of applications, Enjay Butyl rubber stands *unmatched* in its ability to resist ozone and corona, impact and abrasion, moisture and weathering . . . properties that contribute to the *outstanding* performance of Butyl-made products.

Instrument transformers, underground service cables, high voltage industrial cables . . . in these, and many other electrical applications, Enjay Butyl out-performs and out-lasts *all other* types of rubber, synthetic *or* natural. *Low-in-cost* and *immediately available*, this truly wonder rubber may well be able to cut costs and improve performance in *your* products. For further information, and for expert technical assistance, contact the Enjay Company.

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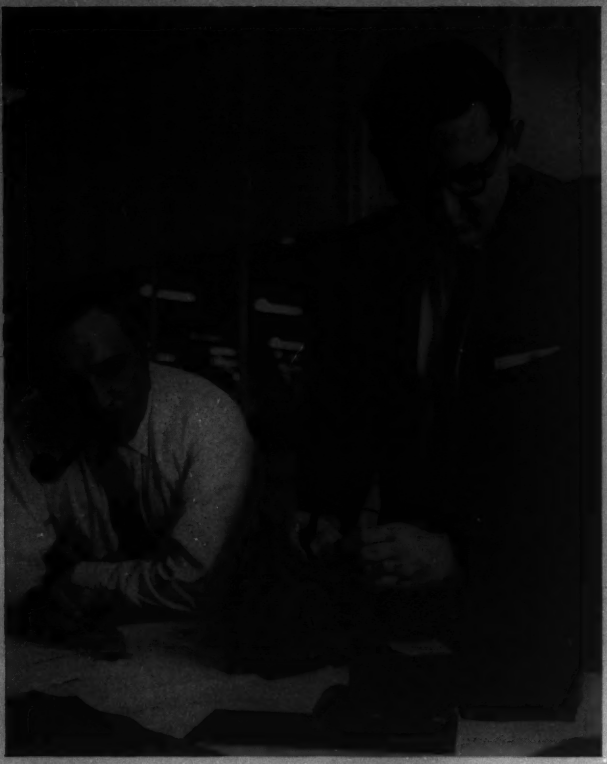
Enjay Butyl is the greatest rubber value in the world . . . the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.



The search for a better product

Products are our business . . . communications our world. Every day that passes finds Federal's growing team of engineers engaged in the search for better products. We believe that better products can come only from effective utilization of the skills, talents and leadership of good engineers. You can understand, then, why we consider our engineers to be this company's greatest asset.

The growth and strengthening of our engineering staff is our constant concern. There are opportunities here for sound, long-range, progressive careers in electronics engineering and telephony.

We earnestly invite you to consider Federal when you think of choosing a company. If you should like to inquire about opportunities here, please write to Mr. Joseph K. Conniington, Technical Placement Director.

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Federal Telephone and Radio Co.

A Division of International Telephone & Telegraph Corporation

100 Kingsland Road, Clifton, N. J.

Industrial Notes

(Continued from page 20A)

110 East Otterman St., Greensburg, Pa., as a result of a recent agreement between the firm and Electronic Instruments Ltd.

Company Acquisition. Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del., has announced the acquisition, as a wholly owned subsidiary, of the Reinhold Engineering and Plastics Co., Inc., Norwalk, Calif., producers and fabricators of plastics for the aircraft missile industry as well as chemical corrosion equipment. The addition of Reinhold will enable Haveg to extend its services on the West Coast and also broaden its product lines with the addition of advanced equipment and know-how in pressure molding techniques of all thermosetting plastics as well as extensive facilities for close tolerance, hand lay-up, and laminating work.

Name Change. Continental Diamond Fibre of Canada Limited is the new name of the Diamond State Fibre Co. of Canada Ltd. In announcing the name change, A. G. Ballard, company president, said it would permit closer identity with the Continental-Diamond Fibre Corporation, a Subsidiary of the Budd Company, Newark, Del. It also marks the first step in a planned program of expansion and diversification.

Hydraulic Press Brakes Installed. A hydraulic press brake has been proved a high-speed production tool in a year-long test conducted at All-Steel Equipment Company. In the typical operation of forming parts for desk drawers in progressive dies, the hydraulic press brake substantially out-produced the older mechanical brakes. Three additional 100-ton brakes are being installed for similar forming operations. Hydraulic press brake is manufactured by Pacific Industrial Manufacturing Co., 848 49th Ave., Oakland, Calif.

New Corporation. Formation of Hydel, Inc., an independent research and development organization to serve general industry, has been announced by 10 former staff members of the Dynamic Analysis and Control Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. The corporation is to be assisted financially by the American Brake Shoe Company. Hydel has opened temporary headquarters at 99 First St., Cambridge, Mass.

Two New Narda Buildings. The Narda Microwave Corporation, Mineola, N. Y., has acquired two new buildings in the vicinity of the present plant at 160 Herricks Rd., as a part of a general expansion program in all areas of the company's operations. Transfer of manufacturing facilities, including electronics, assembly, and production testing, into the first of the new buildings has been completed. This plant, containing approximately 6,500 square feet, will also house a new engineering laboratory.

SAFETY SWITCHES STAND UP UNDER 100,000 AMPERE SHORT CIRCUIT TEST!

INDEPENDENT TESTING LAB RELEASES FINDINGS AFTER GRUELLING "TORTURE RACK" TESTS

Unprecedented tests have been completed on 30 through 600 ampere rated Square D safety switches equipped with high capacity current limiting fuses. During these tests, switches were closed on a short circuit system delivering up to 100,000 amperes (symmetrical—R.M.S.). In addition, the fault was applied on the closed switches. *All switches withstood the shocks without any sign of failure!*

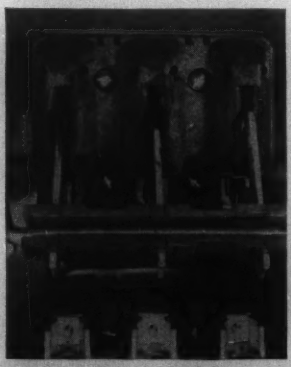
High Capacity Systems Demand Stamina

High capacity systems capable of delivering tremendous short circuits are becoming more and more prevalent with the growth of electrical loads. Network systems in metropolitan areas are a source of such faults. Another, the heavy industrial areas, with a concentration of sub-stations and rotating machinery. Terrific stresses and heat generated by such faults are serious hazards to both personnel and equipment unless properly contained. That is why proven protection for switching service and feeder circuits is of major concern.

Square D Standard Switches Do The Job

These tests offer conclusive proof that standard Square D Type HD and Type ND switches, equipped with high capacity current limiting fuses, can be used on such systems without fear of failure. You pay no premium for the proven performance they offer. Why settle for less?

Square D switch on "torture rack" during test involving up to 100,000 ampere short circuit



SUMMARY TABLE • Extract from Report No. 5/NA R66—Sheet No. 5

Ampere Rating	Voltage Rating	Catalog Number	Average Symmetrical Prospective Current R.M.S.	Recovery Voltage R.M.S.	Maximum Total Arcing Time	Fuse Type
30	250	A85351	98,600	252	.0009	A2Y-30A
30	250	A85351	96,400	253	.0010	FRN-30A
30	600	A85341	107,000	590	.0020	A6Y-30A
30	600	A85341	106,000	601	.0027	FRS-30A
60	250	A86352	96,400	248	.0010	A2Y-60A
60	250	A86352	95,200	252	.0019	FRN-60A
60	600	A86342	106,000	605	.0011	A6Y-60A
60	600	A86342	108,000	598	.0020	FRS-60A
60	600	A86342	107,000	601	.0013	NAS-60A
100	250	A86353	95,200	253	.0009	A2Y-100A
100	600	A86343	108,000	604	.0014	A6Y-100A
200	250	A86354	95,200	253	.0037	A2Y-200A
200	600	A86344	107,000	602	.0011	A6Y-200A
400	250	A86355	96,900	252	.0039	A2Y-400A
400	600	A86345	106,000	611	.0050	A6Y-400A
600	250	A86356	94,500	251	.0062	A2Y-600A
600	600	A86346	107,000	601	.0062	A6Y-600A

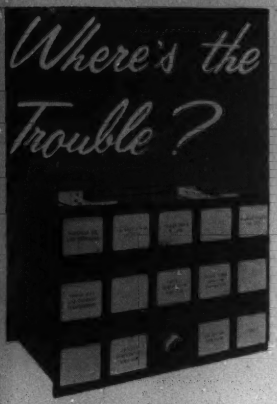
Above • Extract of Nelson High Power Laboratory Report C/NA-66

At left • No sign of failure in this switch interior after 100,000 ampere short circuit test

SQUARE D SAFETY SWITCHES GIVE YOU *Certified* PERFORMANCE!

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY



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Scam sequential annunciator systems provide an audible and flashing visual signal on the first alarm to enable the operator of your control board to determine which point in the monitored process first becomes abnormal . . . successive alarms that develop from the original abnormal condition are indicated by a steady visual signal. You can take proper corrective measures immediately because you know where the trouble started.

Shown here is a typical standardized Scam DE-LINE cabinet with integral flasher and reset pushbutton, featuring all the Scam advantages including simple, compact plug-in design.

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and Vancouver, Canada

NEW PRODUCTS

Proportional Counting System. An entirely new design concept is incorporated in the improved proportional counting system, Model *PC-3A*, introduced by Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind. The instrument is a basic unit in any laboratory that requires precise measurement of alpha, beta, or gamma radiation. New design features have decreased power requirements by 50%, thereby reducing heat and assuring greater reliability and longer life of all components.

Short-Run Nylon Parts. Nylon Molded Products Corporation announces their revolutionary Process N which, through the use of special techniques and unique equipment, offers to the small-quantity user of nylon parts, final-part prices which compare with those charged for longer runs. For detailed literature on Process "N," write for free bulletin: Nylon Molded Products Corporation, Dept. N-4, Garrettsville, Ohio.

Ball Point Marker. An easy-to-use marker in a 6 inch by 1 inch ball-point tube containing a special, fast drying, opaque, heat resistant ink that makes lasting marks on metal, wood, plastic, and glass is now available from John P. Nissen, Jr. Company, Glenside, Pa. The tube can be obtained with green, yellow, blue, orange, black, red, brown, or white ink that will not chip, peel, fade, or rub off and which is ideally suited for marking, numbering, or coding on smooth or rough surfaces. Three different size ball points are available with the tube. For further information, write John P. Nissen, Jr. Company, Glenside, Pa.

Antistatic Plastic Compounds. Antistatic characteristics of new plastic finishing compounds have been announced as a result of tests conducted in the laboratory of the Hanson-Van Winkle-Munning Co. Without antistatic treatment, many plastics acquire a charge of electricity from a processing operation. The charged surface attracts lint and dirt in subsequent handling, and this must be cleaned off by special treatment. The new antistatic finishing compounds offer freedom from this extra treatment, and eliminate special handling procedures necessary when ordinary compounds are used. For more information write to Paul Waalkes, Hanson–Van Winkle–Munning Co., Grand Rapids, Mich.

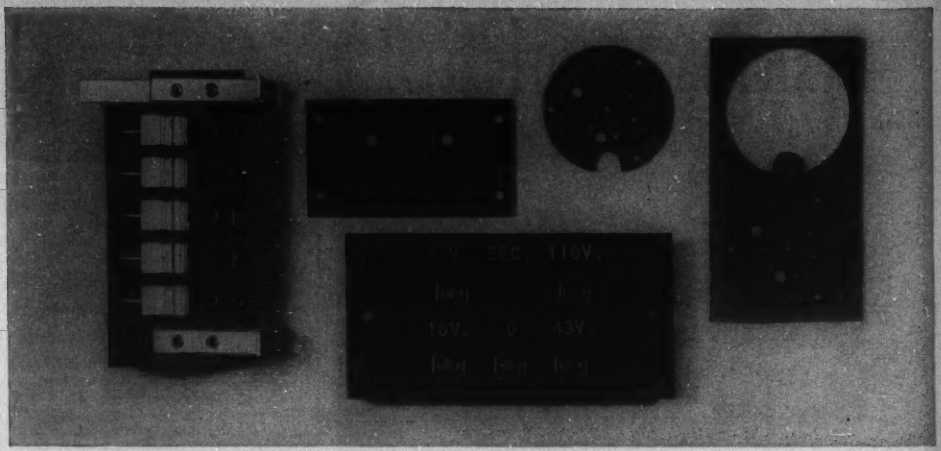
Anodic Wire and Strip Insulation. A process for anodizing aluminum (patent applied for) is now available to the electronic and other industries. It was perfected after many years of research in Europe and the United States. Permaluster Inc., 2012 Burbank Blvd., Burbank Calif. will market aluminum wire and strip coated with this new anodic film. Unlike standard anodizing methods, it is produced in one continuous operation, requires considerably less time to process, and possesses physical properties unobtainable in other anodic films. It is an effective insulation, with a minimum a-c breakdown of 450 volts across two wires twisted together to provide turn-to-turn resistance. It is very flexible, can be bent to a radius only three times its own diameter without crazing or fracturing the film. Various colors can be applied and formed without destroying the protective film. Different hardnesses can be obtained through control of the process. It has high heat resistance and no deterioration has shown in all tests due to high temperature or aging.

Over-the-Floor Duct. Called Electriduct, this new noiseless rubber duct for eliminating serious accidents caused by tripping on electrical wiring, small hoses, and metal tubing lying on top of the floor was designed for workshops, laboratories, factories, offices, etc. It is stumbleproof and unobstructive; heavy equipment on casters rolls over easily. Being made of special rubber, Electriduct is noiseless to foot and caster traffic. The duct is available in two forms: One is a complete electrical extension cord, wired for heavy duty, with a wall plug and cord on one end and a duplex outlet on the other, and is available in various lengths. In the other form, ducts, outlets, and fittings are available separately for special outlet arrangements, as well as for covering cables, wires, small hoses, tubing, etc. For further information contact Ideas, Inc., 615 South 2nd, Laramie, Wyo.

Pressure-Sensitive Plastic Film. Extensive development work has resulted in the production of Kylon, a plastic film, pressure-sensitive tape by Mystik Adhesive Products, Inc., 2635 N. Kildare, Chicago, Ill. Kylon is similar in appearance and application to cellophane tapes but far superior in performance, according to the company's research and development staff. It is available in both transparent and opaque finishes. Applications for Kylon range from sealing, bundling, mending, banding, splicing, and fastening to its use for printed labels in inventory and control. Its properties render it a prime material for general industrial and commercial uses, as well as many special applications in manufacture and installation.

New Gold Alloy. A gold alloy, Secon Alloy No. *443*, for precision potentiometer wire has been announced. Its characteristics are: alternate number: G-80, specific resistance: 80 ohms/circular mil foot, temperature coefficient of resistance (0—100C): 0.0006, tensile strength (psi × 1000): 160.0. For further data, write directly to Secon Metals Corp., 7 Intervale St., White Plains, N. Y.

(Continued on page 34A)



LEADING MANUFACTURERS USE VULCOID. For a punched timer-switch part that operates in oil; for arc chutes in circuit breakers; for the insulation and structural part of an auto-headlight dimmer switch; for a formed electrical switch part carrying 110-volt 60-cycle current; for a mass-produced, 110-volt light-socket part—for these and many more Underwriters-approved parts, CDF Vulcoid is an effective, economical insulation material—good where neither plain fibre nor plain phenolic laminate would suffice.

Fibre gives it high arc-resistance . . .
Aniline resin gives it moisture-resistance

CDF VULCOID

resin-impregnated vulcanized fibre

Vulcoid® is *different*. To the electrical properties of vulcanized fibre we've added the low moisture-absorption of an aniline-type resin with an unusual affinity for cellulose fibers—*all at low cost*. Excellent moisture-resistance (two to four times that of plain vulcanized fibre) helps stabilize Vulcoid's excellent electrical insulating characteristics. Its low cost makes Vulcoid a fine production material for applications of moderate electrical requirements.

Underwriters' approval. Vulcoid is approved by Underwriters' Laboratories as a material for the insulation of current-carrying parts in electrical equipment. It carries the distinctive red and blue thread marking of such materials.

Easy to work. Like vulcanized fibre, Vulcoid is readily drawn or formed into permanent shapes, punched, machined (see illustration above) at low cost. CDF fabrication facilities can give you production quantities of Vulcoid parts to your specifications.

Learn all the advantages of designing around low-cost CDF Vulcoid parts such as arc-deflector spacers, transformer and motor lead bushings, circuit-breaker and transformer barriers, knife-switch guides, transformer coil separators, instrument and contact panels, baseboard receptacles, etc. Ask your CDF man or write for new technical bulletin.

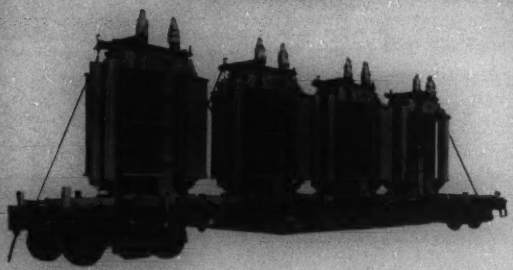
CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Bakelite COMPANY • NEWARK 86, DEL.

COMPARATIVE PROPERTIES

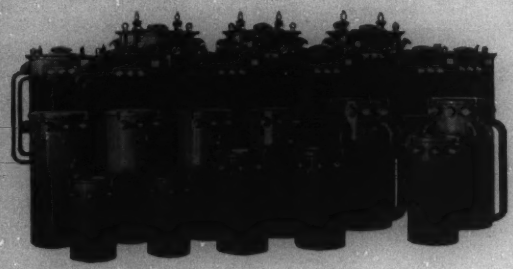
Property	Percent Normal Deviation	Commercial Vulcanized Fibre 1/16"	Paper Base (XX) Phenolic 1/16"	VULCOID 1/16"	1/8"	1/4"	1/2"	3/4"	1"
Arc Resistance, seconds	±25	140	4	110	110	110	110	110	110
Specific Gravity	±10	1.25	1.35	1.35	1.35	1.35	1.30	1.20	1.10
Moisture Absorption, % 24 hours	±25	60	1.4	30	15	6	4	4	4 8
Tensile Strength, —MD thousands of psi. CD	±25	11	12 10	12.5 7.5	12 7.5	11 7	9 6.5	8.5 6	5.5 12
Flexural Strength, —MD thousands of psi. CD	±25	16	19 17	24 19	23 17	20 16	16 13	14 11	9 60
Shearing Strength, —MD thousands of psi. CD	±25	8.5 8	14 12	14 12	12.5 11	12 10			
Compressive Strength, flatwise thousands of psi.	±20	25	34	36	36	36			
Izod Impact Strength MD (Edgewise) Ft. lbs. per inch of notch	±20	2.0	0.50*	1.2	1.2	1.2	1.2		
Dielectric Strength, VPM Perpendicular to surface	±20	175	700	475	425	275	170	100	

NOTE: ASTM test methods used for Specific Gravity, Moisture Absorption, Arc Resistance, Tensile, Flexural, Compressive, and Dielectric Strength.

DESIGNED SPECIFICALLY FOR YOU



POWER transformers rated 2500 KVA are shipped in carload lots.



DISTRIBUTION transformers above are produced by Standard in all commercial voltage ratings and KVA sizes.

Standard is the choice again and again for special services. Famous Standard Transformers, specifically designed for the rugged duty they perform, offer more in design features yet they often cost the same as repetitive models. See your nearby Standard representative or write directly to Warren and get Standard's offer before you place your next contract. You'll be joining users from all over the world who know that you can pay more but you can't buy better than Standard.

THE Standard® TRANSFORMER CO.

WARREN, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

New Products

(Continued from page 24A)

Mechanical Pulse Amplifier–Index Clutch. Digitronics' mechanical pulse amplifier–indexing clutch is the first component to be released for production of a family of mechanical high-speed clutches and brakes recently introduced by the Digitronics Corporation, Albertson Ave., Albertson, L. I., N. Y. This clutch features built-in controls and bearings as well as coaxial input and output shafts; the entire mechanism is contained in a closed envelope of 1-inch diameter by $1\frac{21}{32}$-inch length. The clutch housing has provisions for flange or servo mountings. For further information contact the company.

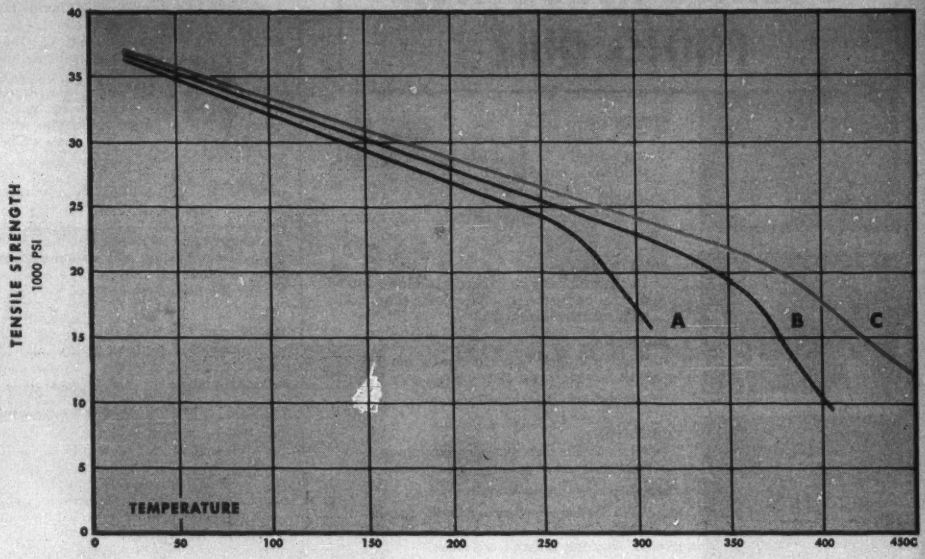
Electrical Connectors. A line of electrical connectors that mount directly through "knock-out" or "threaded" holes in wiring boxes, panels, and ducts; or on small motors and electrically driven hand tools is now being marketed. Called "Change-outs" by the manufacturer, because their use on control equipment (limit switches, solenoids, level detectors, etc.) greatly reduces time required to replace defective units with stand-by units. They are available with two, three, or four contacts for 8 through 20 amperes applications at a 600-volt maximum rating. Those interested in complete information may obtain a copy of Bulletin No. *B68*, by writing Department 0-2, Joy Manufacturing Company, Electrical Products Division, 1201 Macklind Ave., St. Louis 10, Mo.

Loctite. Breakdowns in mechanical equipment caused by loose nuts and bolts now can be eliminated with a liquid lock washer. Called Loctite sealant, this liquid plastic sets up nuts and bolts so securely that no amount of vibration will shake them loose, yet they can be removed with ordinary tools. It replaces lock washers and lock nuts, giving up to five times the removal torque of these devices. Proved in production use for well over a year, Loctite is used in such products as shock

mounts for jets and missiles, chain saws, washing machines, helicopters, freight cars, truck cabs, carburetors, and aircraft instruments. Thread locking kits will be available through industrial and service supply distributors. If your dealer does not yet handle these thread locking kits, write directly to the American Sealants Company, 103 Woodbine St., Hartford 6, Conn., for further information.

(Continued on page 36A)

How silver helps copper conductors at elevated temperatures



THE INFLUENCE of silver on the tensile properties of high-conductivity copper at elevated temperatures. Tests made by the Metallurgical Research Laboratory of The American Brass Company. The test pieces were copper strips, cold-rolled to a temper approximately that of hard-drawn rectangular bus bar.
A. Electrolytic copper, silver content normal
B. Electrolytic copper, silver 8.7 ounces per ton added
C. Electrolytic copper, silver 28 ounces per ton added

In heavily loaded motors and generators, the windings, collector rings, and commutators must retain their strength at the higher operating temperatures that have become the rule. And there are now many other places where copper conductors must operate at temperatures well above those heretofore considered normal.

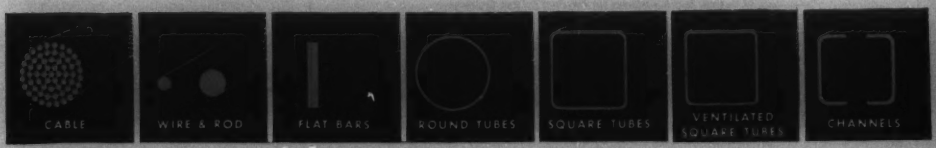
Electrolytic copper—with a very small amount of silver added—is superior to any other commercial conductor metal for use at these higher temperatures. Anaconda silver-bearing copper retains the structural design strength of the conductor at the higher operating temperatures. Annealing temperature is raised and softening delayed. The margin of safety is improved. How much gain you can count on is indicated by the chart above.

More complete information is available in the brand-new Fifth Edition of The American Brass Company's Publication C-25, "Anaconda Copper for Electrical Conductors." In addition, this 62-page booklet has convenient new tables giving physical and electrical data on all types of rigid bus conductors for the most commonly used sizes—plus a wealth of general information on the properties of copper conductors.

TECHNICAL SERVICE. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance — or to get a copy of "Anaconda Copper for Electrical Conductors" — see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 66100

ANACONDA® COPPER CONDUCTORS

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED

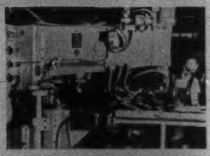


GENERAL ELECTRIC

VOLTAGE REGULATION PHOTO QUIZ

QUESTION:
In infrared drying ovens, what causes scorching or lengthens baking cycle while shortening lamp life?

ANSWER:
"Bad Voltage"—over or under lamp rating.



QUESTION:
In electronically controlled machines, what causes excessive rejects, down-time and high maintenance costs?

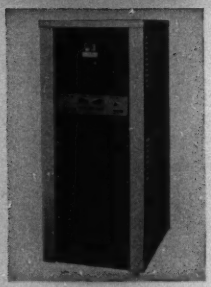
ANSWER:
"Bad Voltage"—over or under nameplate rating.

QUESTION:
What makes electroplating equipment produce poor plate quality, high rejects?

ANSWER:
"Bad Voltage"—over or under nameplate rating.

QUESTION:
What causes electronic computers to give wrong answers, requiring costly down-time and high maintenance?

ANSWER:
"Bad Voltage"—over or under nameplate rating.



QUESTION:
What is the most economical way to eliminate bad voltage?

ANSWER:
An Inductrol* Voltage Regulator, which precisely controls either a-c or d-c voltages. Three types available: motor-operated, hand-operated, automatic (shown left). Has excellent space factor, easy to install, neither affects nor is affected by system power factor. Since it is an induction regulator, it has no brushes, needs essentially no maintenance. Highly reliable.

FOR MORE INFORMATION contact your G-E apparatus representative, or write Section 425-9, General Electric Co., Schenectady 5, N. Y.

*Trademark of General Electric Company for Induction Voltage Regulators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

New Products

(Continued from page 34A)

Low-Cost Immersion-Type Thermostat. Manufactured by Alloy Bellows, Inc., 18125 Roseland Rd., Cleveland 12, Ohio, this thermostat was developed for use where there is a sensitivity of temperature change as low as a fraction of a degree (such as required in processing operations). Yet, it is rugged enough to withstand extreme temperatures above or below the calibrated range. Switch rating: 15 amperes, 125 volts, a-c. Adjustment of temperature setting is accomplished by turning a knob to the desired degree within the calibrated range. The thermostat can be mounted and will work equally well in any position. Further information and descriptive literature can be obtained by writing the manufacturer.

Pushbutton Test Oscillator. A portable, pushbutton test oscillator, featuring all-transistor circuitry, printed wiring, and self-contained power supply, is available from the Alectra Division, Consolidated Electrodynamics Corporation. Known as the Model *21A* test oscillator, the instrument is designed specifically to expedite repetitive-type operations such as are encountered in laboratory, production, and maintenance applications. It provides eight preset frequencies (user-specified) within the range of 15 cycles to 150 kilocycles at a source impedance of less than 0.5 ohm. Further information on the test oscillator appears in CEC Bulletin *7006* available from the Alectra Division, Consolidated Electrodynamics Corporation, 325 No. Altadena Dr., Pasadena, Calif.

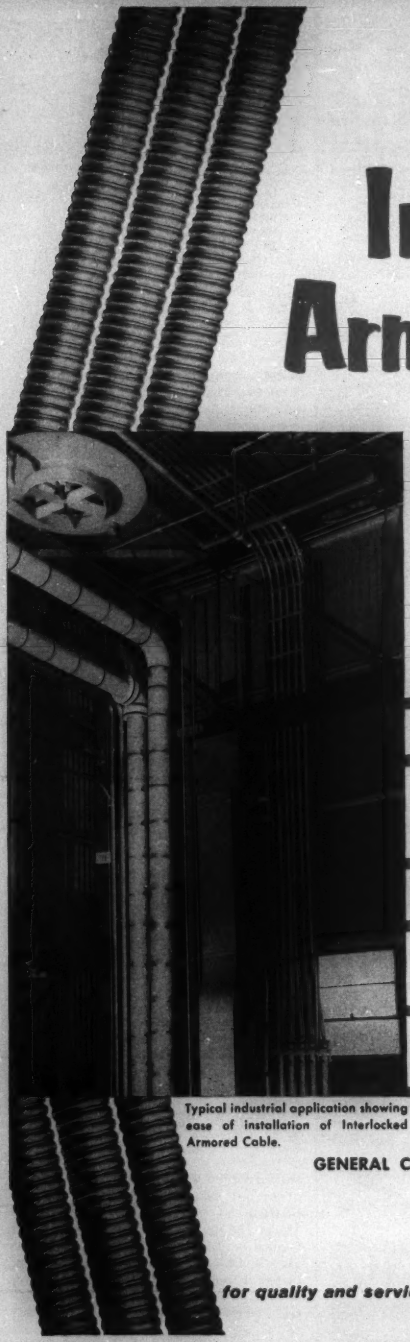
Switch Takes Own Picture. A new method of mounting and the application of a novel pulse switch for flashing lights without destroying them is shown by Tensitron, Inc., 10 Depot St., Harvard, Mass., makers of the Saxl mercury pulse switch. To take the photograph shown, the deflection of the switch actuated the photo-flood light. Fastened to its supporting springs, their manual deflection made the mercury run between the two electrodes for temporary contacting. This initiated the flash thus exposing the picture.

An incandescent lamp can thus be used instead of flash guns using expendable flash bulbs. Since the exposure is short, filament voltages exceeding standard ratings

(Continued on page 40A)

GENERAL CABLE

Interlocked Armored Cable



FOR EVERY CONDITION

Whether constructing a new plant or expanding present power needs, General Cable has the right Interlocked Armored Cable for every condition. Interlocked Armored Cable provides savings through reduction of space requirements and installed costs. Flexibility and accessibility facilitate relocation and extension of existing wiring systems and provide ease of maintenance and repair.

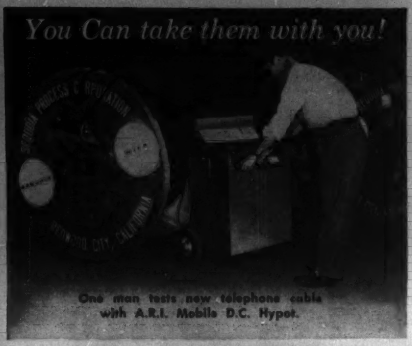
Where a flexible yet well protected cable system is required, it pays to specify General Cable Interlocked Armored Cable.

CONDUCTORS:	copper or aluminum in full range of sizes.
INSULATIONS:	varnished cambric, rubber (Thermax-W, Aquaseal, Gencorone, Butarone), polyvinyl chloride, polyethylene, asbestos-varnished cambric.
ARMORS:	steel, bronze, aluminum.
PROTECTIVE COVERING:	polyvinyl chloride jacket in colors over the armor can be furnished, where required.
VOLTAGE RATINGS:	full voltage range as covered by industry standards.

Typical industrial application showing ease of installation of Interlocked Armored Cable.

GENERAL CABLE CORPORATION, 420 Lexington Avenue, New York 17, N. Y.
Offices and Distributing Centers Coast-to-Coast.

for quality and service... **specify GENERAL CABLE**



One man tests new telephone cable with A.R.I. Mobile D.C. Hypot.

HYPOT®

D. C. HIGH POTENTIAL TESTERS

(Ranges up to 75,000 V.D.C.)

PORTABLE
ACCURATE
EASY TO OPERATE

For testing
Wire • Cable • Potheads
Bushing • Motors
Transformers
Generators

Only one man is required to test with Mobile D.C. Hypots . . . and operation for fast, simple, accurate tests is quickly learned, virtually foolproof.

Mobile Hypots roll like a golf cart—have traveled thousands of miles in station wagons and utility trucks without crating or padding.

Whether you are testing in plant, warehouse or in the field, Mobile D.C. Hypots save time and manpower—give positive, accurate tests of dielectric strength.

Write for new Bulletin 5-1.1, for data on all D.C. "Hypots". Sent free on request.

ASSOCIATED RESEARCH, Incorporated
Electrical Testing Instruments Since 1936

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Field Representatives in Principal Cities
Export Dept., 549 W. Washington Blvd., Chicago 6, Illinois

TELEPHONE AND TELEGRAPH EQUIPMENT

Radio Engineering Products is currently producing a number of types of equipment, electrically and mechanically interchangeable with standard Bell System apparatus.

CARRIER-TELEPHONE EQUIPMENT

C5 Carrier-Telephone Terminal (J68756). A kit for adding a fourth toll-grade channel to existing C systems is available. • C1 Carrier-Telephone Repeater (J68757) • 121A C Carrier Line Filter • H Carrier Line Filter (X66217C).

CARRIER-TELEGRAPH EQUIPMENT

40C1 Carrier-Telegraph Channel Terminal (J70047C) • 140A1 Carrier Supply (J70036A1, etc.) • 40AC1 Carrier-Telegraph Terminal.

VOICE-FREQUENCY EQUIPMENT

V1 Telephone Repeater (J68368F) • Power Supply (J68638A1) • V1 Amplifiers (J68635E2 and J68635A2) • V3 Amplifier (J68649A) • V-F Ringers (J68602, etc.) • Four Wire Terminating Set (J68625G1) • 1C Volume Limiter (J68736C).

D-C TELEGRAPH EQUIPMENT

16B1 Telegraph Repeater (J70037B) • 10E1 Telegraph Repeater (J70021A) • 128B2 Teletypewriter Subscriber Set (J70027A).

TEST EQUIPMENT

2A Toll Test Unit (X63699A) • 12B, 13A, 30A (J64030A) and 32A (J64032A) Transmission Measuring Sets • 111A2 Relay Test Panel (J66118E) • 118C2 Telegraph Transmission Measuring Set (J70069K) • 163A2 Test Unit (J70045B) • 163C1 Test Unit (J70045D).

COMPONENTS AND ACCESSORIES

255A and 209FG Polar Relays • Repeating and Retard Coils, several types • 184, 185, 230A and 230B Jack Mountings.

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE UNiversity 6-6887 CABLES RADENPRO MONTREAL

New Products

(Continued from page 36A)

and thus of higher actinic effectiveness can be used as by the use of a step-up transformer. There are many other instances where a short-time, powerful pulse made in this simple manner, offers great possibilities to the makers and users not only of photographic devices but also of electromechanical equipment.

Pinpoint Oiler. A simple inexpensive device which makes it possible to lubricate extremely small or hard-to-get-to parts of machinery is now available from the Diversified Trading Company, 50 Court St., Brooklyn 1, N. Y. Called the pinpoint oiler, it was specifically designed for those applications where the use of the conventional oilcan is impractical because of its large size. It is ideal for the lubrication of miniaturized components and fine instrumentation.

Drafting Appliqué Material. An appliqué material is now on the market. This material was developed to overcome the problem of appliqués which in the past did not adhere to the drawing paper after long periods of storage. The use of a non-bleeding type glue and a special type backing paper has proved to be the answer to the usual complaints. The APLIKA material is made of a translucent plastic with a fine grain surface that will take pencil, ink, or printing. As the material makes contact with the drawing paper it becomes completely transparent. It is available in sheet form with a special backing in standard sizes of 6 by 9 inches and 8½ by 11 inches. The sheets are available

either plain or printed to any specifications. In unprinted form this material can be printed by standard offset printing equipment using quick drying ink. Non-standard notes can be made on any typewriter using carbon paper ribbons and simply typing on the sheet material. For further details write to Transparent Products Company, Inc., APLIKA Dept., 324 E. 24 St., New York 10, N. Y.

Autographic Plotter. Digital readout operating simultaneously with graphic plotting has been announced for their Model *114* autographic plotter by Gilmore Industries, Inc., 5713 Euclid Ave., Cleveland 3, Ohio. A digital converter can be driven in tandem with the graphic plotter to operate a tape punch, card punch, electric typewriter, or printer. The Model *114*

(Continued on page 46A)

"Five...four...three"...

Two seconds to "FIRE"...the time when your instrumentation cables must work

Are you responsible for any of the equipment involved in scenes of this kind? Any of the instrumentation or telemetering devices?

If so, you well know how little can be left to chance when a $100,000-plus pre-dawn "shot" is scheduled.

Even minor cable trouble at a time like this can be crucial and costly, especially if it happens on the equipment involved for which *you* are responsible.

That's why it's important for you to insist on electronic cables with *maximum built-in reliability*.

Quiz yourself on cable

Here's how to get this kind of reliability. Ask yourself these questions about the cable that's to go into your own equipment:

1. Who is the cable supplier? Has he:
   a. Thorough knowledge of electronic wiring problems?
   b. Engineering and research skill in developing special cable?
   c. Complete facilities for producing custom-built or specification cable?
2. Are his cable conductors full-size, uniformly annealed and precisely stranded?
3. Are his insulations and coverings uniformly applied compounds that have proved workable, dependable?
4. Can he supply those newly developed materials that might be needed?

You'll find all of these qualifications met in full measure by Rome Cable

Millions of feet of Rome wire and cable have already been installed in electronic gear for military and commercial uses. More is ordered every day.

When you require cable that must not fail—or which must meet unusual specifications—we can very probably help you. Simply contact your nearest Rome Cable representative—or write to Department 422, Rome Cable Corporation, Rome, N. Y.

ROME CABLE

CORPORATION

profile of a

...the Lenkurt engineer

What makes him special?

First there's the man himself. Lenkurt attracts the highest caliber.

Then there's the environment in which he lives. At San Carlos, on the sunny San Francisco peninsula, the Lenkurt Engineer enjoys California living at its finest.

Last, and most important, is his working environment. At Lenkurt, in an atmosphere of congeniality and well-being, the engineer finds inspiration for his best creative efforts. His contribution is quickly recognized, promptly rewarded.

Immediate opportunities exist at Lenkurt for some very special guys interested in:

- Components Development Engineering
- Product Planning Engineering
- Applications Engineering
- Circuit Design Engineering

Lenkurt ELECTRIC

Please send your resume to Jack Shannahan, Engineering Placement Manager

New Products

(Continued from page 40A)

autographic plotter is a multichannel recording and plotting instrument for use with strain gauge, thermocouple, or millivolt inputs. It automatically receives and plots each channel on an individual graph so that test personnel can quickly evaluate on-the-spot results, while the test is actually in progress. According to the manufacturer, the plotters reduce reruns and help eliminate faulty test setups and overloaded test specimens. Installations save time, engineering, and technical manpower. The Model *114* autographic plotter is available in 24-, 48-, or 96-channel models. For information, write to the company.

Time-Saving Wiring System. The "Cradleclip" wiring system has been put on the market. The system consists of binders and extensible clips for unsupported wiring, and cradles with extensible clips for anchored wiring. The nylon binders and cradles are virtually unbreakable, the Neoprene extensible clips are tough and flexible. The "Cradleclip" wiring system is reported to take only five seconds for each fixing point. It is suitable for all climates. The system reduces wiring costs and speeds up production lines. For free samples and literature write to Electrovert, Inc., 489 Fifth Ave., New York 17, N. Y.

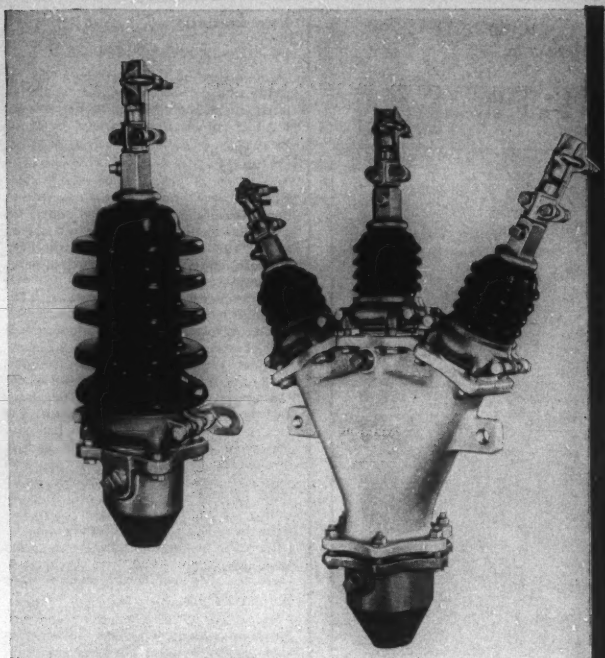
New Cable Splicing Method. A method of splicing single and multiconductor shielded cables has been developed by Burndy Corporation, Norwalk, Conn. The announcement stated that with wider use of single and multiconductor shielded cable in aircraft, electronic, and military

Courtesy Burndy Library

equipment, this method should prove helpful to a growing number of manufacturers. The technique uses standard, inexpensive parts to make compact, flexible, high-conductivity splices with electrical and physical properties comparable to those of the cable.

Swiss Rectifiers. Pumpless steel tank rectifiers with mercury vapor and rare gas filling are the latest additions to the line of heavy duty electrical equipment manufactured by the Secheron Works Co., Geneva, Switzerland, for the American market. The rectifiers are particularly adaptable to the

(Continued on page 48A)



NEW Delta-Star Seal-Kap Terminators are available in both multiple conductor and single conductor types, offered in a wide range of sizes and entrance fittings.

Cutaway of Seal-Kap Terminator conductor showing air-tight O-ring neoprene gasket at porcelain-to-metal joints.

Cutaway of Seal-Kap Terminator base showing pressure-tight seal at metal-to-metal joints.

NEW, advanced line of DELTA-STAR *Permanently-Sealed* Terminators

The big feature of this new line of Delta-Star Seal-Kap Terminators is the permanent-seal construction—using pressure-tight O-ring neoprene gaskets at all joints. The terminator is permanently air-tight and moisture proof, with a partial vacuum created inside it.

Insulating oil and compound inside Seal-Kap Terminators cannot escape even when heating causes expansion. Many sealing arrangements are used on terminators, but none is more effective than the new Seal-Kap method.

Among other Seal-Kap advantages are economy in original cost—and economy through ease of installation and maintenance.

A range of sizes is available to meet most terminator applications—in both multiple and single conductor types. Get complete information—just ask for the new Seal-Kap catalog.

For your best *new* buy in terminators, call on *Delta-Star Electric Division, H. K. Porter Company, Inc., Chicago 12, Illinois. District offices in principal cities.*

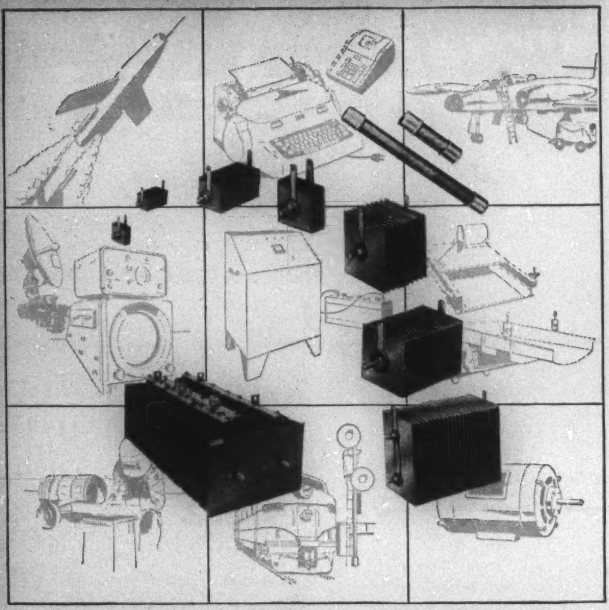
H. K. PORTER COMPANY, INC.

DELTA-STAR ELECTRIC DIVISION

Porter Divisions: Cleveland, Connors Steel, Delta-Star Electric, Henry Disston, Leschen Wire Rope, Quaker Rubber, Refractories, Riverside-Alloy Metal, Vulcan Crucible Steel, W-S Fittings, H. K. Porter Company (Canada) Ltd.

SYNTRON Vacuum Process

SELENIUM RECTIFIERS



peak performance, high quality at low cost

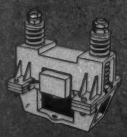
Through their unique vapor deposit process and quality control methods, SYNTRON is able to provide Rectifiers of extreme uniformity, long life and stability. Engineered to meet the most rigid requirements. Constructed from quality materials, treated to withstand adverse climatic conditions. Their low forward voltage drop means greater efficiency, low ageing, and long life. Reverse Cell Voltage rating from 15 volts to 45 volts RMS means fewer cells per stack.

SYNTRON produces the largest variety of selenium cells in the industry. Let our applications engineers make recommendations for your rectifier needs.

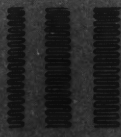
Builders of Quality Equipment for more than a Quarter-Century.

Other SYNTRON Equipment of proven Dependable Quality

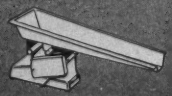
BIN VIBRATORS



SINUATED WIRE



VIBRATORY FEEDERS



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SYNTRON COMPANY
440 Lexington Avenue Homer City, Penna.

New Products

(Continued from page 46A)

requirements of the electrochemical industry, d-c networks of all kinds, electric traction, and rolling mill drives. For further information contact Secheron Works Co., 250 Park Ave., New York 17, N. Y.

Drawn Curve into Voltage Converter. A nonmechanical instrument that converts a curve drawn on graph paper into a voltage to be used to program radiant heat, test load, and other control, programming, or computing applications, has recently been developed by Spar Engineering & Development, Inc., Paxson and South Avenues, Wyncote, Pa. The all-electronic unit, known as the "Program Scanner," operates when a photographic transparency of a curve is inserted in front of the "flying spot" tube which is swept by a vertical line moved horizontally across the face of the tube. The unit does not have the same speed limitations as electromechanical devices. The new scanner's output is available as a variable width pulse or d-c, with a-c output being obtained by adding a converter. Accessory items include an automatic camera to facilitate the making of transparencies, and time base generators to drive the horizontal sweep. For further information write to the company.

Spectrum Analyzer. This instrument analyzes any complex electrical waveform continuously within its frequency range and presents a readout showing the frequencies included in the waveform and the amplitudes of each of the frequency components. Waveforms may be continuous or discontinuous. The analysis is performed over successive 10-second periods. Other periods are available on special order. The readout is a bargraph produced by a pen writing galvanometer showing a frequency spectrum. Each bank consists of plug-in electronic band-pass filters. The frequency and band width should be specified in each request. The extreme stability of the instrument is such that long-term stability is better than 2%. Filter and integrator circuits are set at the factory, and require no readjustment. The only controls requiring setting are those on the amplifier which set the incoming voltage gain, and the pen excursion and selector switches on the amplifier of the spectrum analyzer which establishes the mode of operation. For further information contact Edin Company, 207 Main St., Worcester 8, Mass.

Stud Welding Gun. A new small stud welding gun, weighing one third less than any unit previously marketed and designed to weld studs faster and more reliably, has been introduced by the Nelson Stud Welding Division of Gregory Industries, Inc., Lorain, Ohio. Called the Nelson *NS-10*, the durable red plastic gun is so balanced that it is as easy to handle as a hammer. Despite its small size, this gun will weld all studs up through ½-inch in diameter.

(Continued on page 57A)

New Products

(Continued from page 48A)

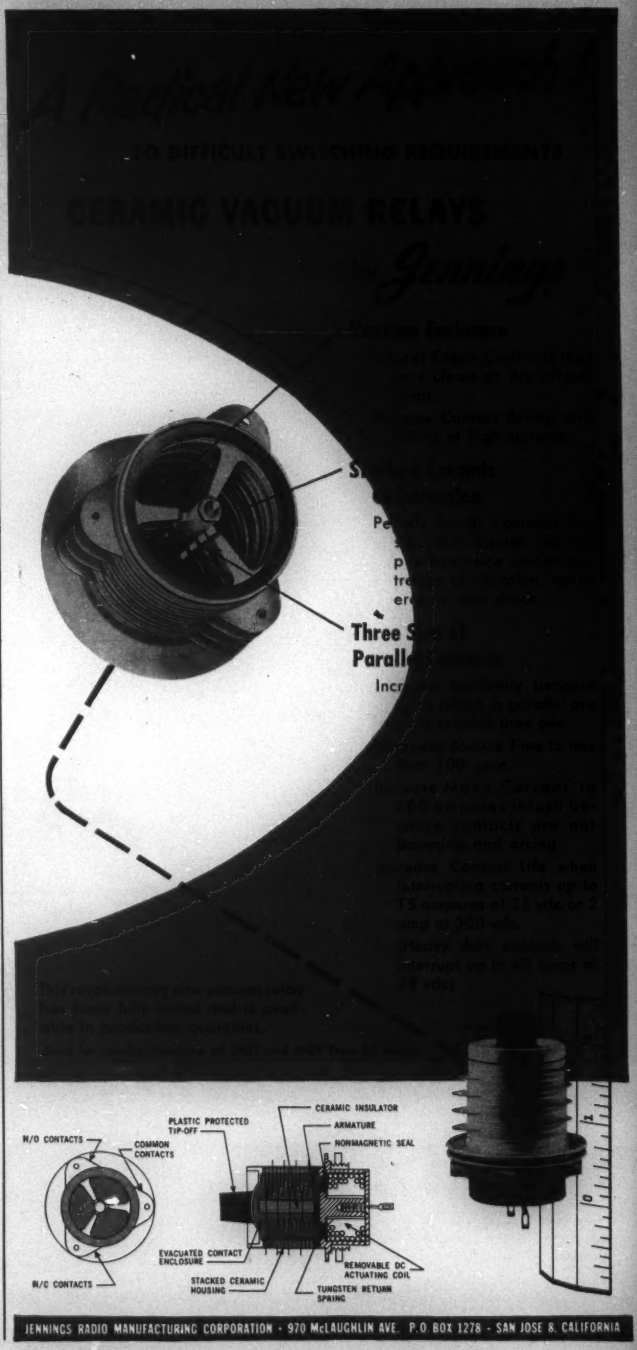
The gun weighs less than 4 pounds and measures only 9 inches long.

Ultra Sensitive Low-Pressure Switch. Development of an economically priced, low-pressure switch to control or signal small pressures, vacuums, or differential pressures has been announced. It is ideally suited for control of movement of roll-type air filters, pressure regulation of gas boosters, switch operation of dampers, blowers, gas-fired heaters, and for similar low-pressure control, safety, or signalling applications. An independently adjustable automatic reset feature extends the use of the switch to many automatic control fields. For further details write to Bacharach Industrial Instrument Company, 200 N. Braddock Ave., Pittsburgh 8, Pa.

Transistorized Amplifier. A 20-watt transistorized plug-in amplifier for public address systems that replaces units more than eight times its size is now available from Universal Transistor Products Corp., 143 E. 49th St., New York 17, N. Y. The unit occupies only 50 cubic inches. It comes with built-in equalization, has a signal-to-noise ratio greater than 30 db, and less than 3% harmonic distortion at the low-frequency end. Input impedance is matched to the tape recorder magnetic playback head. Frequency spectrum from 50 to 20,000 cps available. The amplifier includes peak clipping and gain control, and meets military environmental specifications.

Substation Transformers. A line of substation transformers, Type *LD*, is available. Ratings are through 15 kv, 250 to 500 kva, single phase. The transformer line features a new Lowgrocap (registered trade mark) winding design which distributes surge voltages more evenly, affording added resistance to voltage breakdown. This feature, plus the new "D" core design, provides a smaller and lighter transformer with maximum utilization of tank space. Weight reduction is up to 25%. The round tank with flat fin coolers on one side away from the low-voltage terminals reduces installation area by as much as 35%. For further information, write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

Aluminum Parallel Clamp. With a twist of the wrist, this new aluminum parallel clamp is hooked onto the run. It takes only a few turns of the bolt to open the Type *PCA* clamp enough to slip over its maximum conductor. It is cast from high-strength aluminum alloy, especially treated at the factory to prevent aluminum oxide from reforming, giving a low-resistance path from run to tap. It is filled with "Cual-Aid" contact compounds and packed in individual polyethylene bags. A sample is obtainable, filled with Cual-Aid contact compound, packaged in individual polyethylene bag, from Penn-Union Electric Corporation, State St., Erie, Pa.



GENERAL ELECTRIC SYNCHRONOUS

. . . a NEW relaying principle

Transmission line phase fault protection using compensator distance relays

Relays making up the new K-Dar system provide high-speed protection of transmission lines from three-phase and phase-to-phase faults. K-Dar provides high-speed coverage of 90% of the line section with adjustable time-delay back-up of adjacent line sections . . . or provides simultaneous tripping of circuit breakers on a faulted section as a part of a carrier or micro-wave scheme.

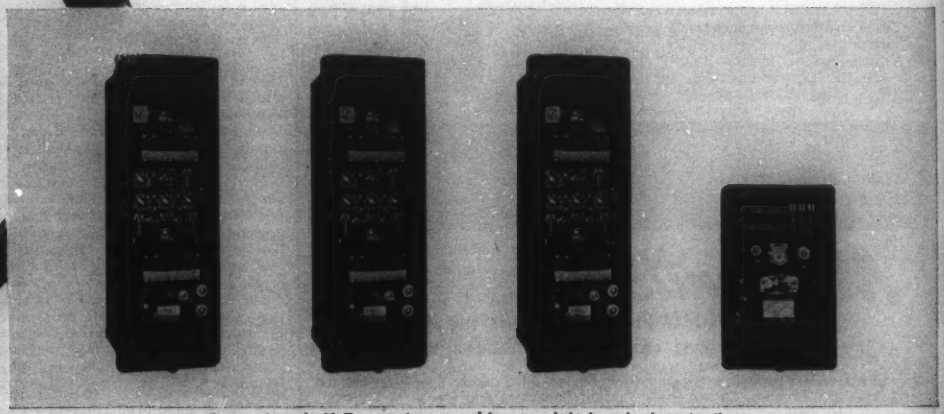
K-Dar is insensitive to transients . . . provides more accurate response to relay settings. Air gap compensators provide effective transient shunt. More reliable response permits relay setting to achieve greater line coverage.

K-Dar phase-to-phase relay unit operates independent of load current . . . Phase-to-phase settings can be made to reach further out on a line section because relay unit operates independent of load current or system-swing conditions.

K-Dar features simplified design . . . Low maintenance with K-Dar . . . few moving parts. With few adjustments, relay setting is much easier . . . testing is reduced to a minimum.

For complete information about the new K-Dar system, call your Westinghouse salesman. Or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-40500

YOU CAN BE SURE...IF IT'S Westinghouse



Four relays in K-Dar system provide complete terminal protection

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ALL SIX!

1. Motor and Generator Brushes
Morganite brushes enjoy a reputation world-wide for trouble-free service. For fractional horsepower, aircraft, automotive, traction and industrial use.

2. Carbon Brush Holders
Assure high efficiency brush operation by maintaining positive contact between the brush and the commutator or ring. Standard types include cantilever radial, radial, trailing, reaction and AC slip ring holders.

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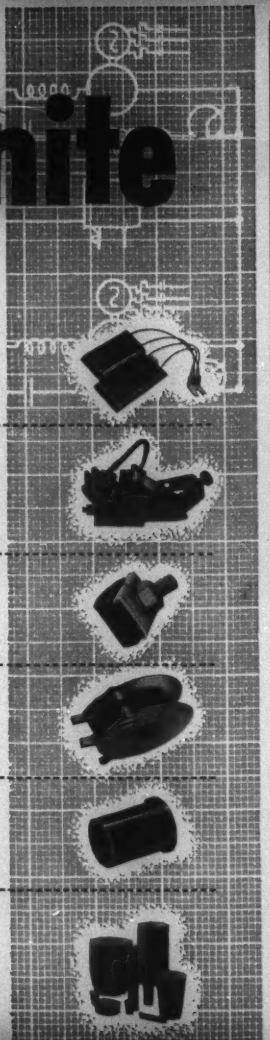
Including drum controllers, contactors and starters. Incorporate metals in a refractory carbon base for improved electrical conductivity and mechanical strength. Self-lubricating; non-welding.

4. Carbon Current Collectors
Reduce operating costs on travelling cranes. Cost less, wear longer and reduce conductor wear to a minimum. Will not blister or rough conductor, afford trouble-free service over long periods.

5. Carbon Specialties
Morganite self-lubricating carbon specialties include bearings, seal noses, piston rings and pistons, pump vanes, valves, radar components and other parts for electrical and mechanical equipment.

6. Morganite Refractories
TRIANGLE RR, impervious recrystallized alumina, crucibles, insulators, pyrometer and furnace tubes. 99.7% Al_2O_3 —max. temp. 1950°C—3542°F. TRIANGLE HS, impervious mullite tubes. Max. temp. 1700°C—3092°F.



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Manufacturers of Fine Carbon Graphite Products including Carbon Specialties, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts

Distributors of 99.7% Pure Al_2O_3 Tubes and Crucibles

TRADE LITERATURE

Asbestos Fiber Brochure. The use of a newly available type of asbestos fiber to reduce costs of molded plastic parts is described in a brochure, "Amveco Asbestos Fibers for Reinforcement of Plastics," published by World Commerce Corporation, S.A. The booklet deals primarily with the use of asbestos fiber in reinforced polyester molding compounds and provides detail on formulations, physical properties, and applications. It discusses how reinforcement with this fiber makes possible the production of parts with excellent physical characteristics at lower costs than parts made with compounds reinforced with other fibers. Copies of the brochure are available on letterhead request to Asbestos Division, World Commerce Corporation, S.A., 445 Park Ave., New York 22, N.Y.

Electrical Stop Clock. Complete technical and application data on a new industrial, laboratory, or military electrical reset time totalizer, Type *691*, are now available in Bulletin No. *PB-691*, published by the Cramer Controls Corporation, Centerbrook, Conn. Containing detailed descriptions of material, rating, and construction specifications, this 4-page bulletin also includes an exploded view of the Cramer device showing design principles. All operating features are explained in detail with suggestions of specific application possibilities.

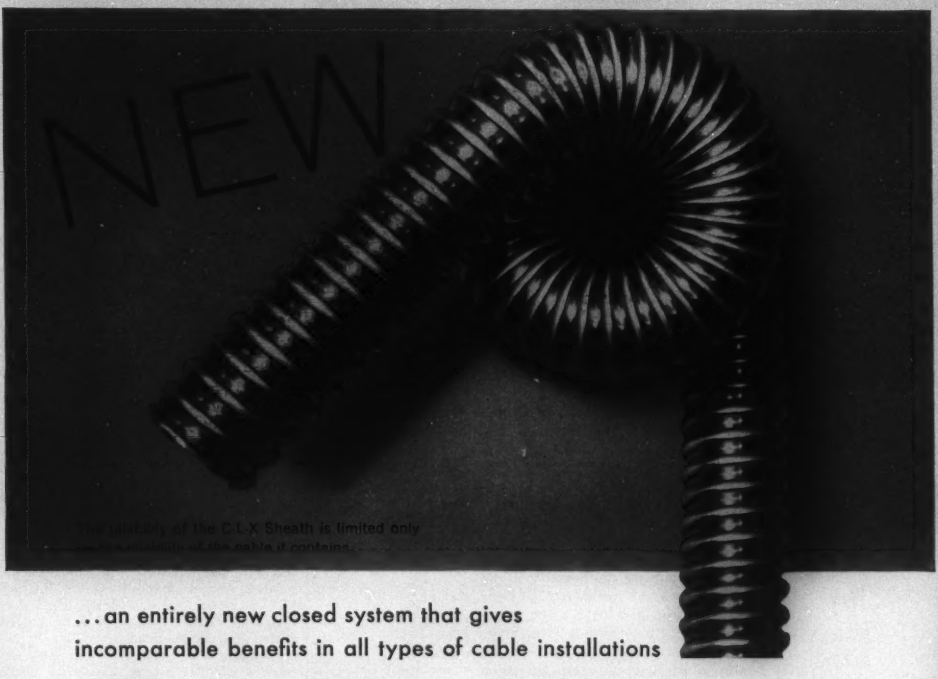
Tantalum Foil Capacitors Bulletin. The distinguishing and unique characteristics of tantalum foil capacitors, their exceptional stability, shelf life, greater capacitance per unit volume, and other characteristics are discussed in Bulletin *152*. Applications and limitations of the polar and nonpolar types of tantalum foil electrolytics are covered. Detailed physical and operational specifications are provided as well as a handy table of many standard capacitance and voltage values. For a copy of this bulletin write the Ohmite Manufacturing Company, 3655 Howard St., Skokie, Ill. Request Bulletin *152*.

How to Select and Apply Floodlights. Essential features of efficient, economical floodlighting installations, are discussed in Bulletin *GEA 6175A*. Its 16 pages also provide a glossary of floodlighting terms, explain the operation of floodlights, include classification and application guides, and provide floodlight product information. In addition, the publication discusses general principles of floodlighting application, gives a step-by-step explanation of how to make floodlighting calculations, provides tables of recommended footcandle levels for various types of installations, lists photometric data on General Electric floodlights, and includes sample floodlighting problems and solutions. Write General Electric Company, Schenectady 5, N.Y.

(Continued on page 72A)

Simplex

ANNOUNCES the C-L-X* Sheath



...an entirely new closed system that gives incomparable benefits in all types of cable installations

Simplex C-L-X is a Continuous Lightweight eXterior metallic sheath that is impervious to gases, chemicals and water. Its unique construction gives it a combination of properties that is unmatched by any cable system now manufactured in the United States.

C-L-X provides a completely sealed conduit — with "built-in" cable. C-L-X combines all the advantages of lead sheathed and interlocked armored cables. In addition, it has its own intrinsic qualities of great strength with extremely light weight. It is suitable for installation in trays or by clamps. C-L-X can be used aerially or buried directly in the ground. Its pliability permits ease of installation.

For more than a decade, this type of cable protection has given exceptional service in European installations. *Now, Simplex engineering has adapted C-L-X so that its scope of industrial applications is practically unlimited for modern American installations.* It is unequalled in situations where impermeability and durability are important.

Like all Simplex products, C-L-X is engineered for lasting quality and, therefore, *dependability*. Write for specific product data.

*(Continuous Lightweight eXterior, pronounced "Sealex")

LIVE BETTER ELECTRICALLY

Simplex WIRE & CABLE COMPANY

79 SIDNEY STREET, CAMBRIDGE 39, MASS.

"the American manufacturers of transoceanic telephone cables"

Serves The Electronics Field

Typical GLASaloy Shapes

P. R. Mallory & Co. Inc., well-known producers of electronic components for many major manufacturers, specify GLASaloy (EG-9) glass reinforced plastic shafts for use in their tuning devices.

Exceptional resistance to heat and corrosion—combined with high torque strength, superior dimensional stability, and high dielectric qualities—give these GLASaloy shafts distinct advantages over other materials.

GLASaloy rods, tubes, and shafts are available in many sizes, shapes and colors . . offer great flexibility of design . . can be engineered to meet varied customer specifications. Mail the coupon below for information on how versatile, low-cost GLASaloy can better serve your needs in the electronics and allied fields.

GLASS REINFORCED PLASTICS CORP.

405 West Sophia Street **Maumee, Ohio**

Gentlemen; I would like more information on GLASaloy.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

Trade Literature

(Continued from page 70A)

Electric Control Applications Folder. This four-page folder describes the design and engineering services of Rundel Electric Company, electric control manufacturer. Illustrated are examples of the wide range of electric control application assignments completed by Rundel in the recent past, with special emphasis on control for automation, crane control, and explosion-proof control. The folder is available from Rundel Electric Company, 230 Adrian Rd., Millbrae, Calif.

Closed-Circuit Television Catalog. A 4-page catalog sheet on a selfcontained closed-circuit television camera, Model *PD-500*, lists outstanding features and fully describes the design characteristics of the camera, built-in power supply, and control accessories for complete remote operation. Detailed specifications and dimensions are also provided. General Precision Laboratory Incorporated, 63 Bedford Rd., Pleasantville, N. Y.

Computer Literature. Three brochures on data processing have been made available. Folder U841 graphically illustrates new advances in common language data-processing. Easy-to-read diagrams showing the use of common language equipment in conjunction with wire transmission facilities, to speed data processing among offices, factories, warehouses, and branches, are highlighted. Random-access magnetic drum data storage are described in *U1062*. Ten specific advantages of magnetic storage drums are outlined. A new type of magnetic tape handling unit with built-in controls, designed especially for the Univac File-Computer System, is described in the brochure, *U1064*. Copies of these three folders may be obtained by writing Remington Rand Univac Division, Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y., asking for the brochures by number.

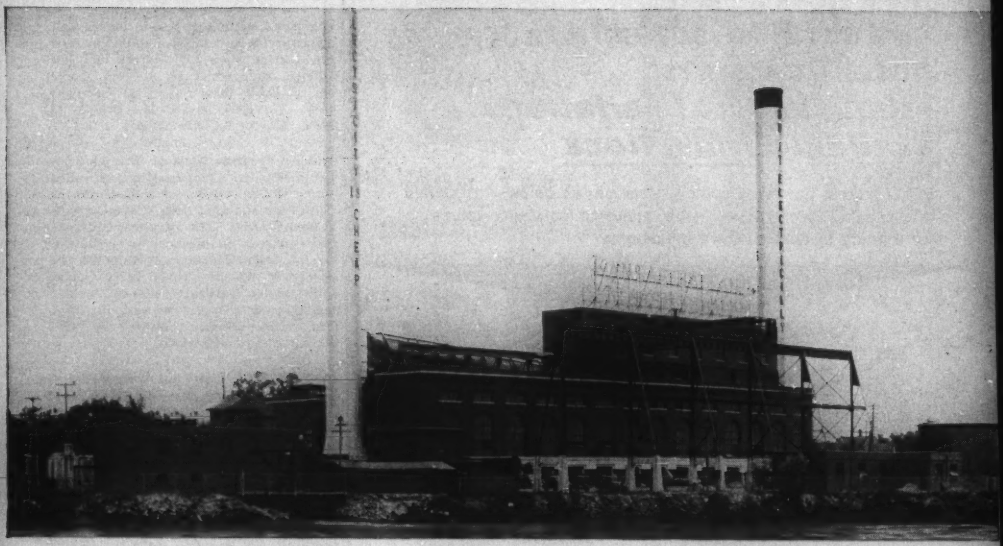
Spherical Head Heater Brochure. A brochure on spherical head feedwater heaters has been published by C. F. Braun & Co., S. Fremont Ave. & Mission, Alhambra, Calif. Copies are available on request.

Boral for Neutron Shielding. A 4-page folder on boral for neutron shielding is available on request from Brooks & Perkins, Inc., 1950 W. Fort St., Detroit 16, Mich. This company is producing boral for use in atomic power installations. The folder describes boral, its composition, uses, and shielding properties.

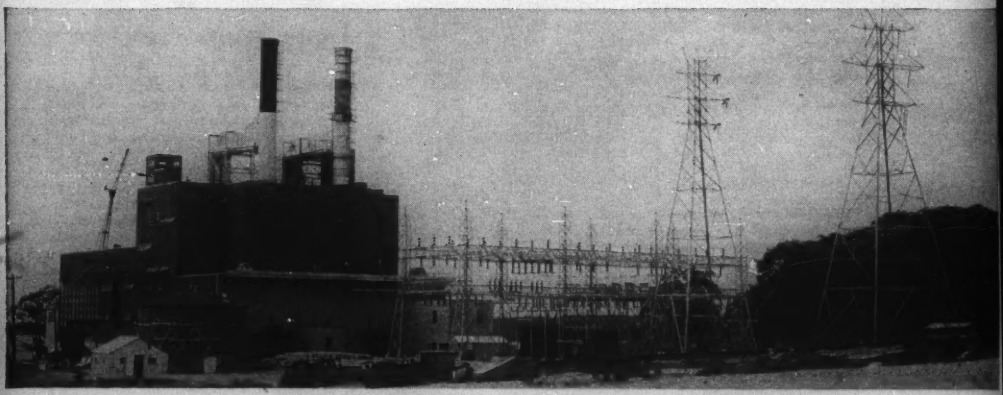
Wide-Range Pulse Generator Bulletin. A wide range pulse generator, Type *1006*, is illustrated and described in a technical bulletin released by the Burroughs Corporation, Electronic Instruments Division, 1209 Vine St., Philadelphia 7, Pa. Free copies are available upon request.

(Continued on page 76A)

350,000 kva Rating



Kansas Gas and Light Co., Wichita, Kans.



Central Maine Power Co., Augusta, Maine

SWITCHGEAR DIVISION

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA

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TRIMPOT®

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SELECT from the many combinations shown below. Any choice is available in a wide selection of standard resistance values... for military or commercial applications.

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WIRE LEADS — SOLDER LUGS — PRINTED CIRCUIT PINS

in these TYPES:

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HIGH OR MEDIUM TEMPERATURE | HUMIDITY PROOF | HIGH RESISTANCE | DUAL OUTPUT | VARIABLE RESISTOR

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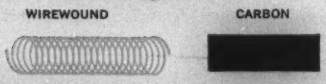

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ALL UNITS FEATURE sub-miniature size... space-saving configuration... self-locking shaft with 25-turn screwdriver adjustment... excellent acceleration, vibration and shock characteristics... mounting individually or in stacked assemblies, with standard 2-56 screws.

Over 50,000 units in stock. Send for complete catalog on the TRIMPOT and related potentiometers.

PLUS THE NEW TRIMPOT JR.

Micro-miniature size 3/16"x3/16"x1" 2.0-watt power rating. Humidity proof. 175°C. max. operating temperature.

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General Offices: 6135 Magnolia Ave., Riverside, Calif.
Plants: Riverside, California—Ames, Iowa

TRIMPOT • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

Trade Literature

(Continued from page 72A)

Package Unit Substations. An 8-page bulletin covering package unit substations has been issued by the Square D Company. It explains the advantages which substations offer when used in modern electrical systems and shows a complete line of the company's equipment which has been designed to meet the needs imposed by modern systems. Both high-voltage and low-voltage components are covered. Copies are available from Square D Company, Dept. SA, 6060 Rivard St., Detroit 11, Mich. Ask for Bulletin *SW-61*.

Rubber Products Catalog. A catalog has been prepared that describes and illustrates Williams-Bowman Rubber Co. facilities for manufacturing rubber parts to customer order. The catalog places special emphasis on the company's facilities for the production of special molded rubber parts, silicone rubber parts, custom built rubber covered rolls, and rubber bonded-to-metal parts. For a copy write to The Williams-Bowman Rubber Co., 1945 S. 54th Ave., Cicero 50, Ill.

Precision Delay Generator Brochure. A 4-page technical brochure, illustrating and describing the operation of a new precision delay generator, Type *6010*, designed as a piece of laboratory-type test equipment for applications which require accurate, variable, time interval pulses, has been published by the Electronic Instruments Division, Burroughs Corporation, 1209 Vine St., Philadelphia 7, Pa. In this brochure, the precision delay is divided into its three operating units, the trigger generator, the delay generator, and the regulated power supply; the operation of each unit is described. Free copies of this brochure are available upon request to the company.

Surface Fluorescent Catalog. A 16-page engineering folio presents specifications, cross-sectional construction drawings, candle-power distribution curves, and coefficients of utilization for a wide line of shielded fluorescent units. The 2-color bulletin presents this data in a clear, functional layout, to afford ease and convenience to the architect and engineer in selecting the units for various applications. For copies of catalog No. *S-58* write to Gruber Brothers, Inc., 125 S. First St., Brooklyn 11, N. Y.

Asbestos Paper Brochure. How industries can save space, time, and money by using Johns-Manville asbestos papers to protect against fire, heat, or corrosion, is described in detail in a brochure now available for general distribution. The brochure also includes a chart showing the thickness, weight, tensile strength, tear strength, and the bursting strength of all of the company's commercial and fibroid asbestos papers. Copies of the brochure can be obtained by writing Johns-Manville Sales Corporation, 22 E. 40 St., New York, N. Y., and asking for *EL-92A*.

(Continued on page 79A)

Trade Literature

(Continued from page 76A)

Carbon Brush Booklet. Getting the best performance out of carbon brushes is the theme of a new booklet, *GEA-6688*, published by the General Electric Company. The 8-page booklet covers brush life, metal transfer, commutator threading, bar marking, and commutator adjustment. The booklet is available free at any General Electric Apparatus Sales office, or from company headquarters, 1 River Rd., Schenectady 5, N. Y.

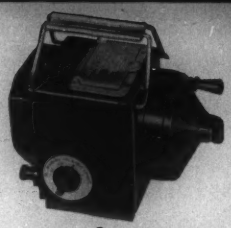
Metal Nameplate Literature. Only 10 seconds are required to apply the new type of deep-anodized, selfbonding metal nameplate manufactured by W. H. Brady Co. "Quik-Plates" have a permanent pressure sensitive adhesive that requires no activation by water, solvent, or heat. Simply remove the Blue Streak Release Liner and apply. Made from 0.004-inch aluminum, the Quik-Plate is backed with Permabond pressure-sensitive adhesive that adheres instantly to metal, glass, plastic, wood, painted, smooth, flat, wrinkled, and curved surfaces. In addition to the pressure-sensitive adhesive type of metal selfbonding nameplate, permanent nameplates that are water, solvent, and heat activated to meet special requirements are offered. All Quik-Plates are made to customer specification for color, size, and bonding method. For samples and literature, write W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.

Automation for the Process Industries. Publication of a 16-page, illustrated brochure on automation has been announced. Written in nontechnical language, the booklet clarifies some of the broader aspects of automation and indicates some of the procedures that have been found useful for its development and application within the process industries. Brochures are available on request from Patterson-Emerson-Comstock, Inc., Automation Division, 313 E. Carson St., Pittsburgh 19, Pa.

Metal Film Precision Resistor Bulletin. A new kind of precision resistor, the Riteohm Series 77 metal film resistor, now available, is described in an informative bulletin. Outlined in full detail are the complete characteristics compared with MIL specifications, resistance range, dimensions, and other important data. For complete information, write for a copy of Bulletin *155*, Ohmite Manufacturing Company, 3661 Howard St., Skokie, Ill.

Nylon Wire Clamps Folder. A 4-page folder describing a fast, lightweight way to secure wires in aircraft, missile, and electronic assemblies is offered by Dakota Engineering, Inc., 6641 Crenshaw Blvd., Los Angeles 43, Calif. The folder details the easy application, positive holding power, and quick modification of nylon wire clamps, and can be obtained upon request to the company.

BIDDLE *Instrument News*



Meg® Type
of Megger
INSULATION TESTER

With NEW A-R-K Switch Gives You ALL THESE FEATURES IN ONE INSTRUMENT

- Megohm Scale ÷ 1 and ÷ 10 (Formerly the A switch)
- Ohm Scale (Formerly the R switch)
- Capacitance Discharge (Formerly the K switch)
- Earth, Line and Guard terminals—no need to change terminal connections when switching to ohm scale

This multi-purpose switch affords you all these features in one instrument. Available with voltages of 500 or 1000 volts d-c and with ranges from 0 to 20 ▪p to 0 to 2000 megohms—0 to 10,000 ohms.

For prices and specifications write for **BULLETIN 21-45-EE**

Biddle Motor and Phase Rotation Tester (*Dual Purpose*)

With it you can...

Determine the direction of rotation of electric motors before they are connected to the line.

Determine the phase rotation or sequence of energized power circuits.

Here is a positive means for determining which motor leads must be connected to certain conductors of a supply system to insure that the motor will rotate in a prescribed direction when energized.

This device will permit the electrical contractor or industrial maintenance electrician to permanently connect and tape the terminals of the motor being installed, without having to first energize the motor by a temporary "hook-up" from a power source, if available, to determine its rotation.

Housed in a sturdy oak case 12¼" x 8¼" x 4¼" this compact unit weighs approximately 10 pounds and is supplied complete with 3 line and 3 motor leads which store in the compartments either side of the instrument panel.

For complete details write for **BULLETIN 80-EE** B-7138

JAMES G. BIDDLE CO.

• ELECTRICAL TESTING INSTRUMENTS
• SPEED MEASURING INSTRUMENTS
• LABORATORY & SCIENTIFIC EQUIPMENT

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CONTROL ENGINEERS

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Move into Large Rocket Engineering and put yourself way ahead in your field

Help us to automate millions of horsepower designed into a jet-size package—the High-Thrust Rocket Engine. Here are the fields:

The Electrical System includes Ground Support and Checkout Equipment which must be operable by military personnel. Aboard the missile, engine controls must be carefully isolated from other missile systems. Miniaturization is striven for, but never at the expense of reliability in extremes of temperature, vibration and acceleration. You'll cover all aspects of circuitry, deal with every branch of weapons systems.

Servo-mechanisms offer a broad spectrum—electronic, pneumatic, mechanical, hydraulic. Your analytical ability will be at a premium here, to evaluate methods of Mixture Control, Thrust Control, and Pressure Control which must compensate for variables like changing mass, drag lapse-rate, altered combustion efficiency, heat, cold, G, vibration etc. You'll be free of routine details, able to apply your training and experience toward a high level of professional growth.

Valves run to 6" diam. and up, with very high pressures and flow rates, extremely rapid action, temperatures down to −300°F.

This is where the real advanced work in controls is being done. Join the trailbreakers. Write, giving your background: A. W. Jamieson, Engineering Personnel Dept. EE-121, 6633 Canoga Avenue, Canoga Park, California.

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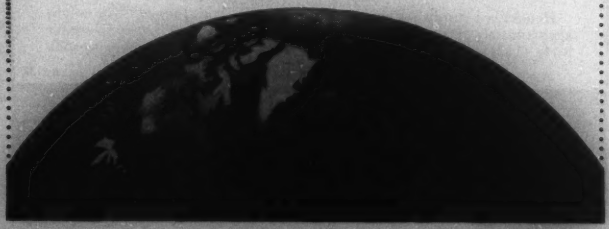

VIGILANCE

The final victory over cancer will come from the research laboratory.

But there is a more immediate victory at hand today. Many cancers can be cured when detected early and treated promptly. *Vigilance* is the key to this victory.

There are certain signs which might mean cancer. Vigilance in heeding these danger signals could mean victory over cancer for you:

1. Unusual bleeding or discharge.
2. A lump or thickening in the breast or elsewhere.
3. A sore that does not heal.
4. Change in bowel or bladder habits.
5. Hoarseness or cough.
6. Indigestion or difficulty in swallowing.
7. Change in a wart or mole.

If your signal lasts longer than two weeks, go to your doctor to learn if it means cancer.

AMERICAN CANCER SOCIETY